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# Compilation of Excitation Cross Sections for He Atoms by Electron Impact

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# Compilation of Excitation Cross Sections for He atoms by Electron Impact

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Abstract

Experimental and theoretical data are compiled on the cross section for the excitation of He atoms by electron impact. The available data are compared graphically. The survey of the literature has been made through the end 1991.

Key words;

He atom, excitation by electron impact, compilation

## I. Introduction

The excitation cross sections for He atoms are of fundamental importance in both laboratory and astrophysical plasmas. In nuclear fusion experiment, an injection of He beam is proposed for plasma diagnostics and heating. The study of diagnostics and heating requires the knowledge of the penetration and energy deposition of the He beam. These processes depend exclusively on the atomic collision involving He atoms. For a large tokamak such as ITER, where the electron density is high, the ladder-like (multi-step) processes play a significant role. In relation to this problem, data are needed on the collision of He atoms in their metastable ( e.g., 1s2s $^3$S) state.

Many experimental and theoretical works have been done for the excitation cross sections of He atoms by electron impact. Some review articles (e.g., de Heer and Jansen (1977), Bransden and McDowell (1978), Aggarwal et al.(1984), Heddel and Gallagar (1989)) include detailed discussions about the excitation cross section of He. Here we have compiled the theoretical and experimental excitation cross sections of He available through the end of 1991. A survey has been made on the absolute total cross section but no differential cross section is compiled here.

The experimental methods are classified mainly into two categories; the radiation measurements and the electron energy loss measurements. For the radiation measurements absolute calibration for the line intensity and the corrections with cascade and polarization effects are necessary. Various theoretical methods have been applied to calculate the cross sections; Born, Ochkur, distorted wave, eikonal, Glauber, many-body and R-matrix approximations.

Recently an assessment of the excitation of He has been made by de Heer et al.(1992). They have determined a set of recommended cross sections. Those are based on the 29-state R-matrix calculation at energies below the ionization threshold and on the first Born approximation by Bell et al.(1969) for the asymptotic behavior at high energy. For intermediate energy, the experimental data obtained by the optical method are employed as a standard.

The graphs are shown in Sec. V in the same order as listed in Sec. II (List of compiled data). As is seen in the figures, the agreements between experimental data and theoretical data are not necessarily satisfactory. The data from the excited states are not available enough. Further studies are clearly needed. The present compilation would serve as a guide indicating where we need the future study.

In graphs the excitation cross sections in $cm^2$ are given as a function of the energy of incident electron in eV for each transition. A letter "T" or "E" (after the authors and the year of publication in the legend) indicates a theoretical or an experimental paper, respectively.

Acknowledgement

The authors would like to thank Mr. E. Asano for making graphs.

## References for Introduction

Aggarwal, K.M. , Kingston, A.E., and McDowell, M.R.C., Astrophys. J. 278, 874(1984)

Bell, K.L., Kennedy, D.J. and Kingston, A.E., J. Phys. B, 2, 26(1969)

Bransden, B.H. and McDowell, M.R.C., Phys. Rep. 46, 249 (1978)

de Heer, F.J. and Jansen, R.H.J. J. Phys. B. 10, 3741(1977)

Heddel, D.W.O. and Gallagher,J.G., Rev. Mod. Phys. 61, 221(1989)

de Heer, F.J., Huckster, R., Kingston, A.E. and Summers, H.P., Nuclear Fusion (1992) to be published.

II. List of compiled data

## III. Table for excitation energies

| Final | Initial 1s2 1S E(eV) | E(Ryd) | Initial 1s2s 3S E(eV) | E(Ryd) | Initial 1s2s 1S E(eV) | E(Ryd) | Initial 1s2p 3P E(eV) | E(Ryd) |
|---|---|---|---|---|---|---|---|---|
| 1s2s 3S | 19.818 | 1.4567 | | | | | | |
| 1s2s 1S | 20.614 | 1.5152 | 0.796 | 0.0585 | | | | |
| 1s2p 3P | 20.963 | 1.5408 | 1.144 | 0.0841 | 0.348 | 0.0256 | | |
| 1s2p 1P | 21.217 | 1.5594 | 1.398 | 0.1028 | 0.602 | 0.0443 | 0.254 | 0.0187 |
| 1s3s 3S | 22.717 | 1.6697 | 2.899 | 0.2131 | 2.103 | 0.1545 | 1.754 | 0.1289 |
| 1s3s 1S | 22.919 | 1.6846 | 3.101 | 0.2279 | 2.304 | 0.1694 | 1.956 | 0.1438 |
| 1s3p 3P | 23.006 | 1.6909 | 3.187 | 0.2343 | 2.391 | 0.1758 | 2.043 | 0.1502 |
| 1s3d 3D | 23.072 | 1.6958 | 3.254 | 0.2392 | 2.458 | 0.1807 | 2.109 | 0.1550 |
| 1s3d 1D | 23.073 | 1.6959 | 3.254 | 0.2392 | 2.458 | 0.1807 | 2.110 | 0.1551 |
| 1s3p 1P | 23.086 | 1.6968 | 3.267 | 0.2401 | 2.471 | 0.1816 | 2.123 | 0.1560 |
| 1s4s 3S | 23.592 | 1.7341 | 3.774 | 0.2774 | 2.978 | 0.2189 | 2.630 | 0.1933 |
| 1s4s 1S | 23.672 | 1.7399 | 3.854 | 0.2833 | 3.058 | 0.2247 | 2.709 | 0.1991 |
| 1s4p 3P | 23.708 | 1.7425 | 3.888 | 0.2858 | 3.092 | 0.2273 | 2.744 | 0.2017 |
| 1s4d 3D | 23.735 | 1.7445 | 3.916 | 0.2879 | 3.120 | 0.2293 | 2.772 | 0.2037 |
| 1s4d 1D | 23.735 | 1.7445 | 3.917 | 0.2879 | 3.120 | 0.2294 | 2.772 | 0.2038 |
| 1s4f 3F | 23.736 | 1.7446 | 3.917 | 0.2879 | 3.121 | 0.2294 | 2.773 | 0.2038 |
| 1s4f 1F | 23.736 | 1.7446 | 3.917 | 0.2879 | 3.121 | 0.2294 | 2.773 | 0.2038 |
| 1s4p 1P | 23.741 | 1.7450 | 3.922 | 0.2883 | 3.126 | 0.2298 | 2.778 | 0.2042 |
| 1s5s 3S | 23.970 | 1.7619 | 4.152 | 0.3052 | 3.356 | 0.2467 | 3.008 | 0.2211 |
| 1s5s 1S | 24.010 | 1.7647 | 4.191 | 0.3081 | 3.395 | 0.2496 | 3.047 | 0.2240 |
| 1s5p 3P | 24.027 | 1.7660 | 4.208 | 0.3093 | 3.412 | 0.2508 | 3.064 | 0.2252 |
| 1s5d 3D | 24.041 | 1.7671 | 4.223 | 0.3104 | 3.427 | 0.2519 | 3.078 | 0.2263 |
| 1s5d 1D | 24.041 | 1.7671 | 4.223 | 0.3104 | 3.427 | 0.2519 | 3.079 | 0.2263 |
| 1s5f 1F | 24.041 | 1.7671 | 4.223 | 0.3104 | 3.427 | 0.2519 | 3.079 | 0.2263 |
| 1s5f 3F | 24.042 | 1.7671 | 4.223 | 0.3104 | 3.427 | 0.2519 | 3.079 | 0.2263 |
| 1s5p 1P | 24.044 | 1.7673 | 4.226 | 0.3106 | 3.430 | 0.2521 | 3.082 | 0.2265 |
| 1s6s 3S | 24.167 | 1.7763 | 4.349 | 0.3197 | 3.553 | 0.2612 | 3.205 | 0.2356 |
| 1s6s 1S | 24.190 | 1.7780 | 4.371 | 0.3213 | 3.575 | 0.2628 | 3.227 | 0.2372 |
| 1s6p 3P | 24.199 | 1.7787 | 4.381 | 0.3220 | 3.585 | 0.2635 | 3.237 | 0.2379 |
| 1s6d 3D | 24.208 | 1.7793 | 4.389 | 0.3226 | 3.593 | 0.2641 | 3.245 | 0.2385 |
| 1s6d 1D | 24.208 | 1.7793 | 4.389 | 0.3226 | 3.593 | 0.2641 | 3.245 | 0.2385 |
| 1s6f 1F | 24.208 | 1.7793 | 4.390 | 0.3226 | 3.594 | 0.2641 | 3.245 | 0.2385 |
| 1s6f 3F | 24.208 | 1.7793 | 4.390 | 0.3226 | 3.594 | 0.2641 | 3.245 | 0.2385 |
| 1s6p 1P | 24.209 | 1.7794 | 4.391 | 0.3228 | 3.595 | 0.2642 | 3.247 | 0.2386 |

From Charlotte E. Moore, NSRDS-NBS 35 (1971)

## IV. References for Graphs


Amus'ya, M.Ya., Chernysheva, L.V., Sheinerman, S.A.
Sov. Phys.-Tech. Phys., 29, 849 (1984)
Excitation of the helium 2 $^3$S triplet level by low- and moderate- energy electrons
T, Many-Body theory, second order corrections are included
37 - 235 eV

Anderson, R.J., Hughes, R.H., Norton, T.G.,
Phys. Rev., 181, 198 (1969)
Excitation of the 3 $^{1,3}$D and 4 $^{1,3}$F levels of helium by direct electron impact, and
4 $^1$P -> 4 $^{1,3}$F collisional transfer.
E, Beam method, radiation, cascade correction
38 - 100 eV

Anderson, R.J., Hughes, R.H., Tung, J.H., Chen, S.T.
Phys. Rev. A, 8, 810, (1973)
Excitation of the 4 $^3$S and 3 $^3$P levels of helium by electron impact.
E, Beam method, radiation, cascade correction
50 - 400 eV

Badnell, N.R.
J. Phys. B, 17, 4013 (1984)
Electron impact excitation of He.
T, Distorted wave
2.54 - 202 eV

Baye, D., Heenen, P.-H.
J. Phys. B, 7, 938 (1974)
A theoretical study of fast electron-helium scattering.
T, 22 state second order potential

Bell, K.L., Eissa, H., Moiseiwitsch, B.L.
Proc. Phys. Soc. A, 88, 57 (1966)
First-order exchange approximation: the excitation of the 2 $^3$S and 2 $^3$P states of helium by electron impact
T, Born with exchange, Wave function (final state) from Morse et al.
44 - 218 eV

Bell, K.L., Kennedy, D.J., Kingston, A.E.
J. Phys. B, 2, 26 (1969)
Accurate first Born approximation cross sections for the excitation of helium by fast electrons
T, Born
25 - 5000 eV

Berrington, K.A., Bransden, B.H., Coleman, J.P.
J. Phys. B, 6, 436 (1973)

The use of second order potentials in the theory of the scattering of charged particles by atoms. IV electron scattering of helium atoms
T, Second order potential
50 -300 eV

Berrington, K.A., Burke, P.G., Freitas, L.C.G., Kingston, A.E.
J. Phys. B, 18, 4135 (1985)
Electron excitation from the 1 $^1$S, 2 $^3$S and 2 $^1$S states of helium. An eleven-state R-matrix calculation.
T, 11 state R matrix
threshold - 30 eV

Berrington, K.A., Kingston, A.E.
J. Phys. B, 20, 6631 (1987)
Electron excitation in helium : including the n = 4 levels in an R-matrix calculation.
T, 19-state R matrix
29.2 eV

Bhadra, K., Callaway, J., Henry, R.J.W.
Phys. Rev. A, 19, 1841 (1979)
Electron-impact excitation of n=2 levels of helium at intermediate energies.
T, Close coupling with exchange 5-levels, DCS (Differential Cross Section)
30 - 100 eV

Bogdanova, I.P., Yurgenson, S.V.
Opt. & Spectrosk., 61, 156 (1986)
Cross sections for direct electronic excitation of atomic levels: measurements using a pulsed electron beam and time scanning of radiation.1: Helium, n = 3.
E, Beam method, time scanning of radiation
50 - 100 eV

Bransden, B.H., Issa, M.R.
J. Phys. B, 8, 1088 (1975)
The use of second-order potentials in the theory of scattering of charged particles by atoms. VIII. excitation of the n = 3 levels of helium by electron and proton impact.
T, Second order potential
100 - 500 eV

Brongersma, H.H., Knoop, F.W.E., Backx, C.
Chem. Phys. Lett., 13, 16 (1972)
Total electron-impact excitation cross sections of helium
E, Double retarding potential difference, electron energy loss
20 - 24 eV

Brunger, M.J., McCarthy, I.E., Ratnavelu, K., Teubner, P.J.O., Weigold, A.M., Zhou, Y., Allen, L.J.
J. Phys. B, 23, 1325 (1990)
Differential cross sections for elastic and inelastic n = 2 excitation of ground-state helium at 29.6 and 40.1 eV
T, 10 state coupled channels with optical potential
30 - 40 eV

Buckley, B.D., Walters, H.R.J.
J. Phys. B, 8, 1693 (1975)
Second Born approximation to electron and positron impact excitations of the 1 $^1$S - 2 $^1$S transition in helium
T, Born
50 -1000 eV

Cartwright, D.C., Csanak, G., Trajmar, S., Register, D.F.
Los Alamos Scientific Laboratory Report, LA-UR-90-3360 (1990)
Electron-Impact Excitation of the n $^1$P Levels of He: Theory and Experiment.
E, Crossed beam method, electron energy loss, DCS
30 - 100 eV

Cartwright, D.C., Csanak, G., Trajmar, S., Register, D.F.
Los Alamos Scientific Laboratory Report, LA-UR-90-3360 (1990)
Electron Impact Excitation of the n $^1$P Levels of He: Theory and Experiment.
T, First Order Many Body Theory
threshold - 500 eV

Chan, F.T., Chang, C.H.
Phys. Rev. A, 12, 1383 (1975)
Cross sections for excitation of the n $^1$D states of helium by electron impact and polarization of the resulting radiation in Glauber theory
T, Glauber
40 - 1000 eV

Chutjian, A., Srivastava, S.K.
J. Phys. B, 8, 2360 (1975)
Experimental-theoretical comparisons of 1 $^1$S - 2 $^1$P differential magnetic sublevel cross sections for electron-helium scattering at 60 eV and 80 eV
E, Beam method, electron energy loss, DCS
60 - 80 eV

Chutjian, A., Thomas, L.D.
Phys.Rev.A, 11, 1583 (1975)
Experimental and (first-order many-body) theoretical differential and integral cross sections for excitation of the n=3 states of He by electron impact at 29.2 and 39.7 eV.
E, Crossed beam method, electron energy loss, DCS
29 - 40 eV

Coleman, J.P.
J. Phys. B, 3, 1413 (1970)
Evaluation of a class of integrals by summing Legendre series
T, First Born approximation
300 - 500 eV

Crooks, G.B., DuBois, R.D., Golden, D.E., Rudd, M.E.
Phys. Rev. Lett., 29, 327 (1972)

Observation of a broad resonance in the 2 $^3$S excitation of helium by electron impact.
E, Beam method, scattered electrons, DCS
40.1 - 69.7 eV

de Jongh, J.P.,van Eck, J.
7th ICPEAC, Abstracts of papers, 701 (1972)
Absolute cross sections for n $^1$P excitation of helium by electrons ( comparison of the results measured under different conditions ).
E, Beam method, radiation, corrections with self absorption, cascade and polarization.
40 - 2000 eV

Dillon, M.A., Lassettre, E.N.
J. Chem. Phys., 62, 2373 (1975)
A collision cross section study of the 1 $^1$S - 2 $^1$P and 1 $^1$S - 2 $^1$S transitions in helium at kinetic energies from 200 -700 eV. Failure of the Born approximation at large momentum changes
E, Crossed Beam method, DCS
200 - 700 eV

Donaldson, F.G., Hender, M.A., McConkey, J.W.
J. Phys. B, 5, 1192 (1972)
Vacuum ultraviolet measurements of the electron impact excitation of helium
E, Beam method, radiation
30 - 2000 eV

Felden, Madeleine M.
Physica, 84C, 439 (1976)
Cross-section calculations for excitation of helium atom by electron and hydrogen atom in Ochkur-Born approximation
T, Ochkur
22 - 200 eV

Flannery, M.R., McCann, K.J.
J. Phys. B, 8, 1716 (1975)
A ten-channel eikonal treatment of differential and integral cross sections and of the ( lamda, chi ) parameters for the n = 2 and 3 excitations of helium by electron impact.
T, Multichannel Eikonal approximation
40 - 500 eV

Flannery, M.R., McCann, K.J.
Phys. Rev. A, 12, 846 (1975)
Ten-channel eikonal treatment of electron-metastable-helium collisions: differential and integral cross sections for 2$^{1,3}$P and n = 3; excitations from He (2$^{1,3}$S) and the ( lamd, chi, pi ) parameters.
T, Multichannel Eikonal approximation
5 - 100 eV

Fon, W.C., Berrington, K.A., Kingston, A.E.
J. Phys. B, 13, 2309 (1980)
The 1 $^1$S -> 2 $^1$S and 1 $^1$S -> 2 $^1$P excitation of helium by electron impact.

T, five-state R matrix
26.5 - 200 eV

Fon, W.C., Berrington, K.A., Burke, P.G., Kingston, A.E.
J. Phys. B, 14, 2921 (1981)
Total cross sections for electron excitation transitions between the 1 $^1$S, 2 $^3$S, 2 $^1$S, 2 $^3$P and 2 $^1$P states of atomic helium.
T, 5-state R matrix, DCS
0.27 - 200 eV

Fon, W.C., Berrington, K.A., Kingston, A.E.
J. Phys. B, 24, 2161 (1991)
Electron impact excitation of the n $^{3,1}$P (n = 2, 3 and 4) states of helium.
T, 19 state R matrix
22 - 30 eV

Hall, R.I., Joyez, G., Mazeau, J., Reinhardt, J., Schermann, C.
Le J. de Physique, 34, 827 (1973)
Electron impact differential and integral cross sections for excitation of the n = 2 states of helium at 29.2 eV, 39.2 eV and 48.2 eV
E, Crossed beam method, electron energy loss, DCS
29.2 - 48.2 eV

Jobe, J.D., St. John, R.M.
Phys. Rev., 164, 117 (1967)
Absolute measurements of the 2 $^1$P and 2 $^3$P electron excitation cross sections of helium atoms
E, Beam method, radiation, cascade correction
22 - 400 eV

Joez, G., Huetz, A., Landau, M., Mazeau, J., Pichou, F.
9th ICPEAC, Abstracts of papers, 827 (1975)
Absolute differential and integral cross sections for electron impact excitation of the n=2 states of Helium from threshold to 3.5eV above.
E, Beam method, electron energy loss, DCS
21.4 - 23.2 eV

Johnston, A.R., Burrow, P.D.
J. Phys. B, 16, 613 (1983)
Near-threshold excitation of He 2 $^3$S by electron impact.
E, Trapped electron, normalised to the ionisation cross section of Rapp and Englander-Golden (1965)
20.35 eV

Katiyar, A.K., Srivastava, Rajesh
Phys. Rev. A, 38, 2767 (1988)
Distorted-wave calculation of the cross sections and correlation parameters for $e^{\pm}$ - He (1 $^1$S, 2 $^1$S -> 2 $^1$P, 3 $^1$S, and 3 $^1$P) collisions.
T, Distorted Wave Born
3.9 - 200 eV

Kay, R.B., Simpson, C.G.
J. Phys. B, 21, 625 (1988)
Electron impact excitation of triplet D, F and G levels of helium : absolute cross sections at 100 eV.
E, Beam method, radiation, correction with cascade
100 eV

Khayrallah, G.A., Chen, S.T., Ramble, J.R.,Jr.
Phys. Rev. A, 17, 513 (1978)
Inelastic scattering of electron by metastable helium: first Born and Glauber cross sections for 2 $^3$S - 3 $^3$S excitation.
T, Glauber
5 - 100 eV

Kim, Y.K., Inokuti, M.
Phys. Rev., 181, 205 (1969)
Generalized Oscillator Strengths of the Helium Atom. II. Transitions from the Metastable States.
T, First Born approximation
10 - 2000 eV

Mansky, E.J., Flannery, M.R.
J. Phys. B, 23, 4573 (1990)
The multichannel eikonal theory of electron-helium collisions : I. Excitation of He (1 $^1$S).
T, Multichannel Eikonal approximation
24 - 2000 eV

Mansky, E.J.
Nonequilibrium Process in Partially Ionized Gases, 349 (1990), Edited by M.Capitelli and J.N.Bardsley, Plenum Press, New York
Electron collision cross sections involving excited states.
T, Multichannel Eikonal approximation
6 - 96.6 eV

Mathur, K.C., Rudge, M.R.H.
J. Phys. B, 7, 1033 (1974)
On the excitation of the 2 $^3$S, 3 $^3$S and 4 $^3$S states in helium by electron impact.
T, Coulomb Born Oppenheimer II
24 - 200 eV

Mathur, K.C., McEachran, R.P., Parcell, L.A., Stauffer, A.D.
J. Phys. B, 20, 1599 (1987)
Inelastic scattering of electrons from the 2 $^3$S state of helium.
T, Distorted wave
11 - 33 eV

McCarthy, I.E., Ratnavelu, K., Weigold, A.M.

J. Phys. B, 21, 3999 (1988)
Continuum effects in electron-helium total cross sections.
T, Coupled channels with optical potential
30 -100 eV

McConkey, J.W., Woolsey, J.M.
6th ICPEAC, Abstracts of papers, 355 (1969)
Electron impact excitaitons of helium
E, Beam method, radiation, corrections with cascade and polarization
24 - 2000 eV

McConkey, J.W., Donaldson, F.G., Hender, M.A.
Phys. Rev. Lett., 26, 1413 (1971)
"Polarization-free" vacuum-ultraviolet excitation of helium by electrons
E, Crossed beam method, radiation, polarization free, corrections with cascade
22 - 196 eV

Moustafa Moussa, H.R., de Heer, F.J., Schutten, J.
Physica, 40, 517 (1969)
Excitation of helium by 0.05-6 keV electrons and polarization of the resulting radiation
E, Crossed beam method, radiation, corrections with cascade and polarization
50 - 6000 eV

Nakazaki, S., Berrington, K.A., Sakimoto, K., Itikawa, Y.
J. Phys. B, 24, L27 (1991)
Differential cross sections of helium for 1 $^1$S-2 $^3$S, 2 $^3$P by electron impact at 100 and 200 eV
T, 11 state R matrix
82 - 200 eV

Narain, U., Chandra, S.
Physica, 77, 623 (1974)
Excitation cross sections of 1 $^1$S -> m $^1$P transitions in helium by electron impact.
T, Semi empirical
20 - 20,000 eV

Ochkur, V.I., Bratsev, V.F.
Opt. Spectry., USSR 19, 274 (1965)
Exchange Excitation of Helium by Electron Impact.
T, Ochkur approximation
22 - 500 eV

Ochkur, V.I., Bratsev, V.F.
Soviet Astronomy-AJ, 9, 797 (1966)
Excitation of helium from the 2$^3$S state by electron collision
T, Ochkur approximation
2 - 100 eV

Rall, David L.A., Sharpton, Francis A., Schulman, M.Bruce, Anderson, L.W.

Lawler, J.E., Lin, Chun C.
Phys. Rev. Lett., 62, 2253 (1989)
Cross sections for electron-impact excitation out of metastable helium levels.
E, Crossed beam method, Apparent cross sections including cascade
4.5 - 16 eV

Rice, J.K., Truhlar, D.G., Cartwright, D.C., Trajmar, S.
Phys. Rev. A, 5, 762 (1972)
Effect of charge polarization on inelastic scattering: Differential and integral cross sections for excitation of the 2 $^1$S state of helium by electron impact
E, Beam method, Scattered electron, DCS, normalized to 2 $^1$P.
26.5 - 81.6 eV

Sawey, P.M.J., Berrington, K.A., Burke, P.G., Kingston, A.E.
J. Phys. B, 23, 4321 (1990)
Electron scattering in helium at low energies: a 29-state R-matrix calculation.
T, 29-state R-matrix
20 - 26 eV

Scott, T., McDowell, M.R.C.
J. Phys. B, 8, 1851 (1975)
Electron impact excitation of n $^1$S and n $^3$S states of He at intermediate energies.
T, Distorted wave polarized orbital I
20 - 575 eV

Scott, T., McDowell, M.R.C.
J. Phys. B, 8, 2369 (1975)
Electron impact excitation of He (n $^1$S), (n=4, 5) at intermediate energies.
T, Distorted wave polarized orbital I, II
40 - 300 eV

Scott, T.
Thesis (1976) London University
T, Distorted wave polarized orbital I, II
25 - 300 eV

Sethuraman, S.K., Rees, J.A., Gibson, J.R.
J. Phys. B, 7, 1741 (1974)
Angular differential cross sections for elastically scattered electrons in helium
T, First Born approximation
50 - 500 eV

Shemansky, D.E., Ajello, J.M., Hall, D.T., Franklin, B.
Astrophys. J., 296, 774 (1985)
Vacuum ultraviolet studies of electron impact of helium: excitation of He n $^1$P$^o$ Rydberg series and ionization-excitation of $He^+$ nl Rydberg series
E, Beam method, radiation, corrections with cascade and polarization
22 - 2000 eV

Showalter, J.G., Kay, R.B.
Phys. Rev. A, 11, 1899 (1975)
Absolute measurement of total electron-impact cross sections to singlet and triplet levels in helium
E, Beam method, radiation, corrections with cascade and polarization
50 - 800 eV

St.John, R.M., Miller, F.L., Lin, C.C.
Phys. Rev., 134, A888, (1964)
Absolute electron excitation cross sections of helium.
E, Beam method, radiation, correction with polarization and cascade
60 - 200 eV

Thomas, L.D., Csanak, G., Taylor, H.S., Yarlaggada, B.S.
J. Phys. B, 7, 1719 (1974)
The application of first order many-body theory to the calculations of the differential and integral cross sections for the electron impact excitation of the 2 $^1$S, 2 $^1$P, 2 $^3$S, 2 $^3$P states of helium
T, Many-Body theory
40 - 80 eV

Ton-That, D., Manson, S.T., Flannery, M.R.
J. Phys. B, 10, 621 (1977)
Cross sections for excitation and ionization in e-He (2 $^1$, $^3$S) collisions
T, First Born approximation
5 - 1000 eV

Trajmar, S.
Phys. Rev. A, 8, 191 (1973)
Differential and integral cross sections for the excitation of the 2 $^1$S, 2 $^3$S, and 2 $^3$P states of He by electron impact at 29.6 and 40.1 eV
E, Crossed beam method, electron energy loss, DCS
29.6 - 40.1 eV

Tully, J.A.
J. Phys. B, 13, 4845 (1980)
Excitation of He(1 $^1$S -> 3 $^3$D) by electron impact
T, Coulomb Born Oppenheimer II, frozen-core Hartree-Fock wavefunctions (post)
23.4 - 222 eV

Van Eck, J., de Jongh, J.P.
Physica, 47, 141 (1970)
Determination of absolute cross sections for excitation of n $^1$P levels of helium by electron impact (30 -1000 eV)
E, Crossed beam method, radiation, corrections with cascade and polarization
30 - 1000 eV

Van Raan, A.F.J., de Jongh, J.P., van Eck, J., Heideman, H.G.M.
Physica, 53, 45 (1971)

Absolute cross sections for excitation of helium by electrons (20 - 2000 eV) and the polarization of the emitted radiation
E, Beam method, radiation, corrections with cascade and polarization
25 - 2000 eV

Van Raan, A.F.J., Moll, P.G., van Eck, J.
J. Phys. B, 7, 950 (1974)
Absolute cross sections for excitation of the 4 $^3$S, 3 $^3$P, and 4 $^3$D levels of helium by electron impact: Measurements at very low target-gas pressures.
E, Beam method, radiation, corrections with cascade and polarization
100 - 1000 eV

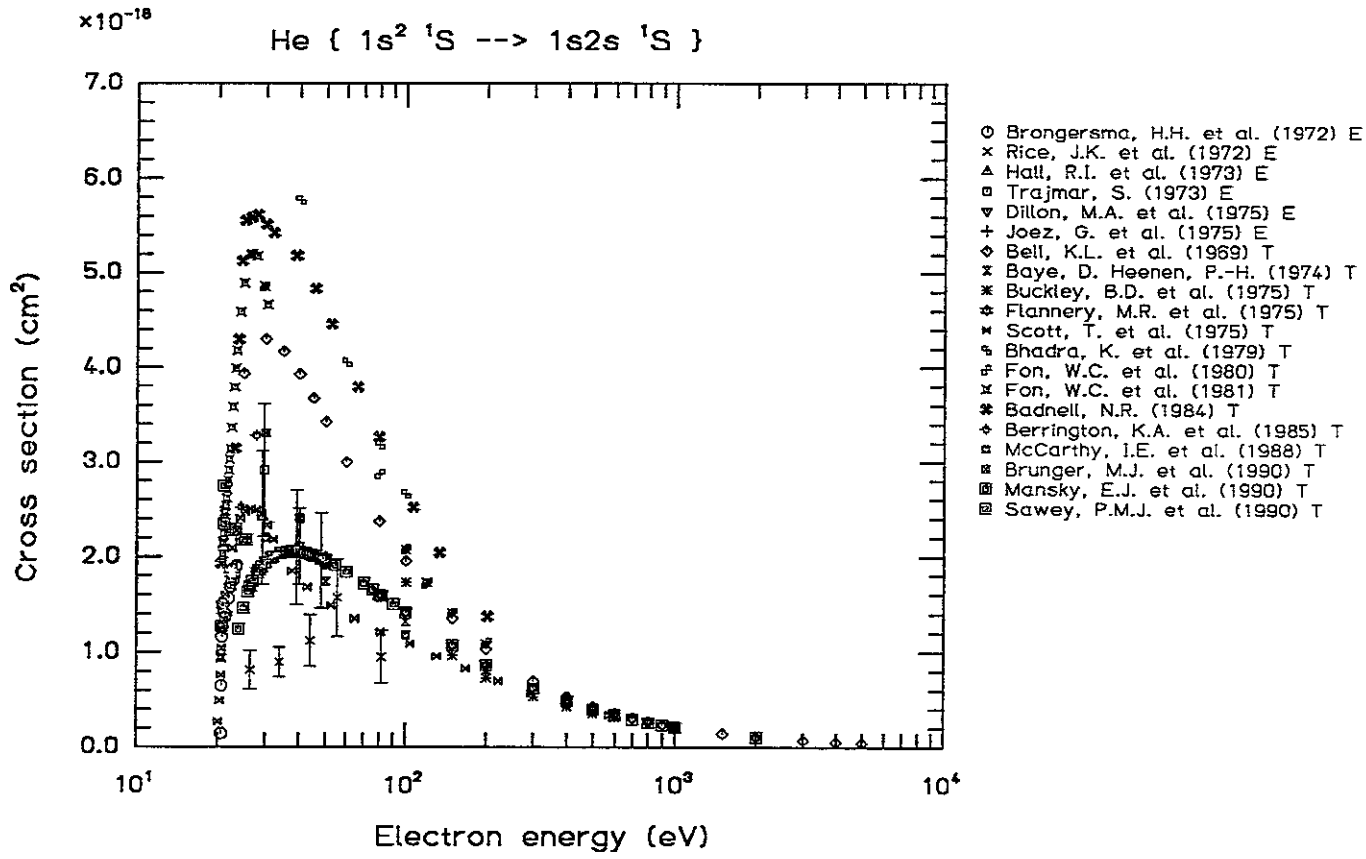
Van Zyl, B., Dunn, G.H., Chamberlain, G., Heddle, D.W.O.
Phys. Rev. A, 22, 1916 (1980)
Benchmark cross sections for electron-impact excitation of n $^1$S levels of He
E, Beam method, radiation, corrections with cascade, benchmark
50 - 2000 eV

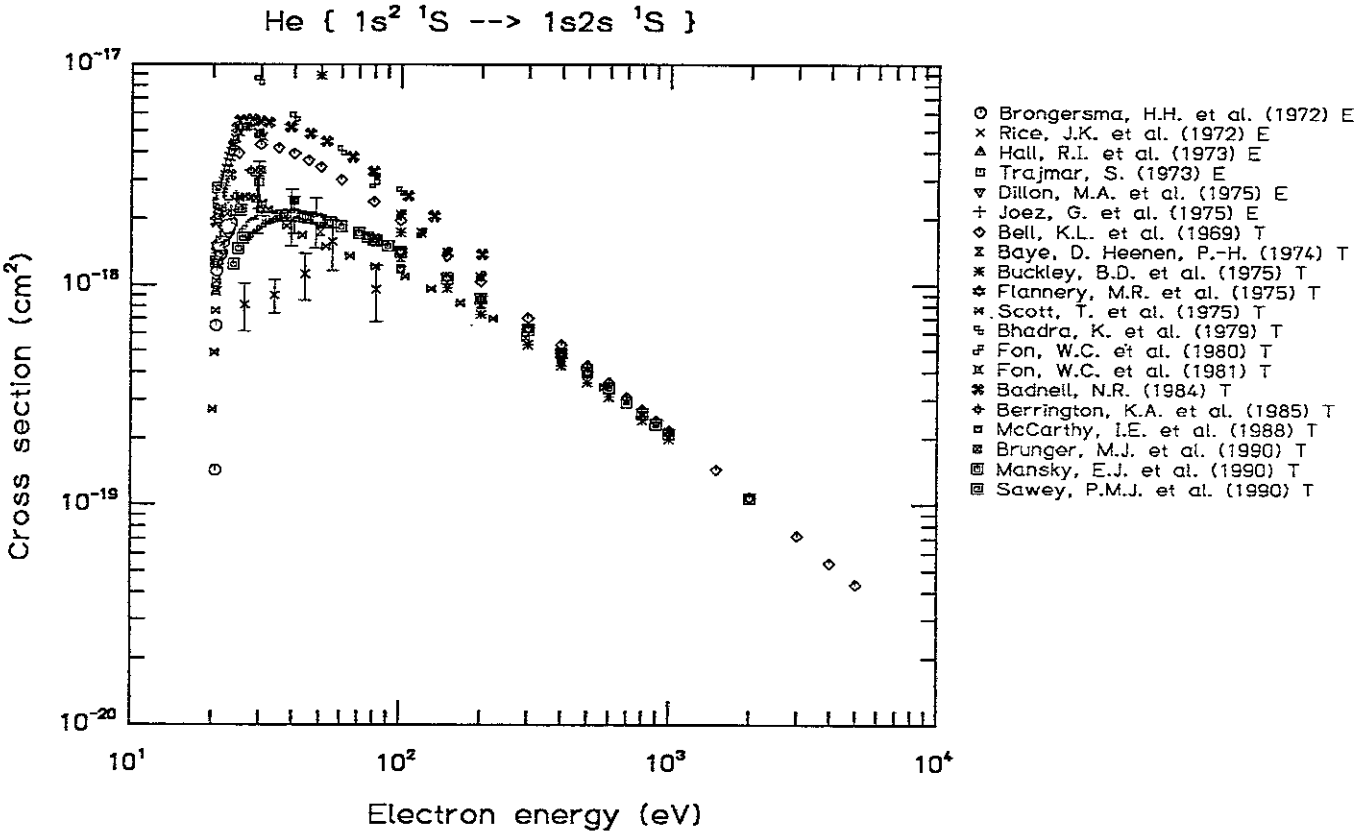
Vanderpoorten, R.
Physica 48, 254 (1970)
Inelastic scattering of high-energy electrons by helium.
T, First Born approximation
50 - 2000 eV

Vriens, L., Simpson, J.A., Mielczarek, S.R.
Phys. Rev., 165, 7 (1968)
Tests of Born approximations: Differential and total 2 $^3$S, 2 $^1$P, and 2 $^1$S cross sections for excitation of He by 100- to 400-eV electrons
E, Beam method, electron energy loss, DCS
100 - 225 eV

Westerveld, W.B., Heideman, H.G.M., Van Eck, J.
J. Phys. B, 12, 115 (1979 )
Electron impact excitation of 1 $^1$ S - 2 $^1$P and 1 $^1$S - 3 $^1$P of helium: excitation cross sections and polarisation fractions obtained from XUV radiation
E, Beam method, radiation, cascade corrections

V. Graphs


He { 1s² ¹S --> 1s2s ¹S }
×10⁻¹⁸
Cross section (cm²)
Electron energy (eV)
Brongersma, H.H. et al. (1972) E
Rice, J.K. et al. (1972) E
Hall, R.I. et al. (1973) E
Trajmar, S. (1973) E
Dillon, M.A. et al. (1975) E
Joez, G. et al. (1975) E
Bell, K.L. et al. (1969) T
Baye, D. Heenen, P.-H. (1974) T
Buckley, B.D. et al. (1975) T
Flannery, M.R. et al. (1975) T
Scott, T. et al. (1975) T
Bhadra, K. et al. (1979) T
Fon, W.C. et al. (1980) T
Fon, W.C. et al. (1981) T
Badnell, N.R. (1984) T
Berrington, K.A. et al. (1985) T
McCarthy, I.E. et al. (1988) T
Brunger, M.J. et al. (1990) T
Mansky, E.J. et al. (1990) T
Sawey, P.M.J. et al. (1990) T


He { 1s² ¹S --> 1s2s ¹S }
Cross section (cm²)
Electron energy (eV)
Brongersma, H.H. et al. (1972) E
Rice, J.K. et al. (1972) E
Hall, R.I. et al. (1973) E
Trajmar, S. (1973) E
Dillon, M.A. et al. (1975) E
Joez, G. et al. (1975) E
Bell, K.L. et al. (1969) T
Baye, D. Heenen, P.-H. (1974) T
Buckley, B.D. et al. (1975) T
Flannery, M.R. et al. (1975) T
Scott, T. et al. (1975) T
Bhadra, K. et al. (1979) T
Fon, W.C. et al. (1980) T
Fon, W.C. et al. (1981) T
Badnell, N.R. (1984) T
Berrington, K.A. et al. (1985) T
McCarthy, I.E. et al. (1988) T
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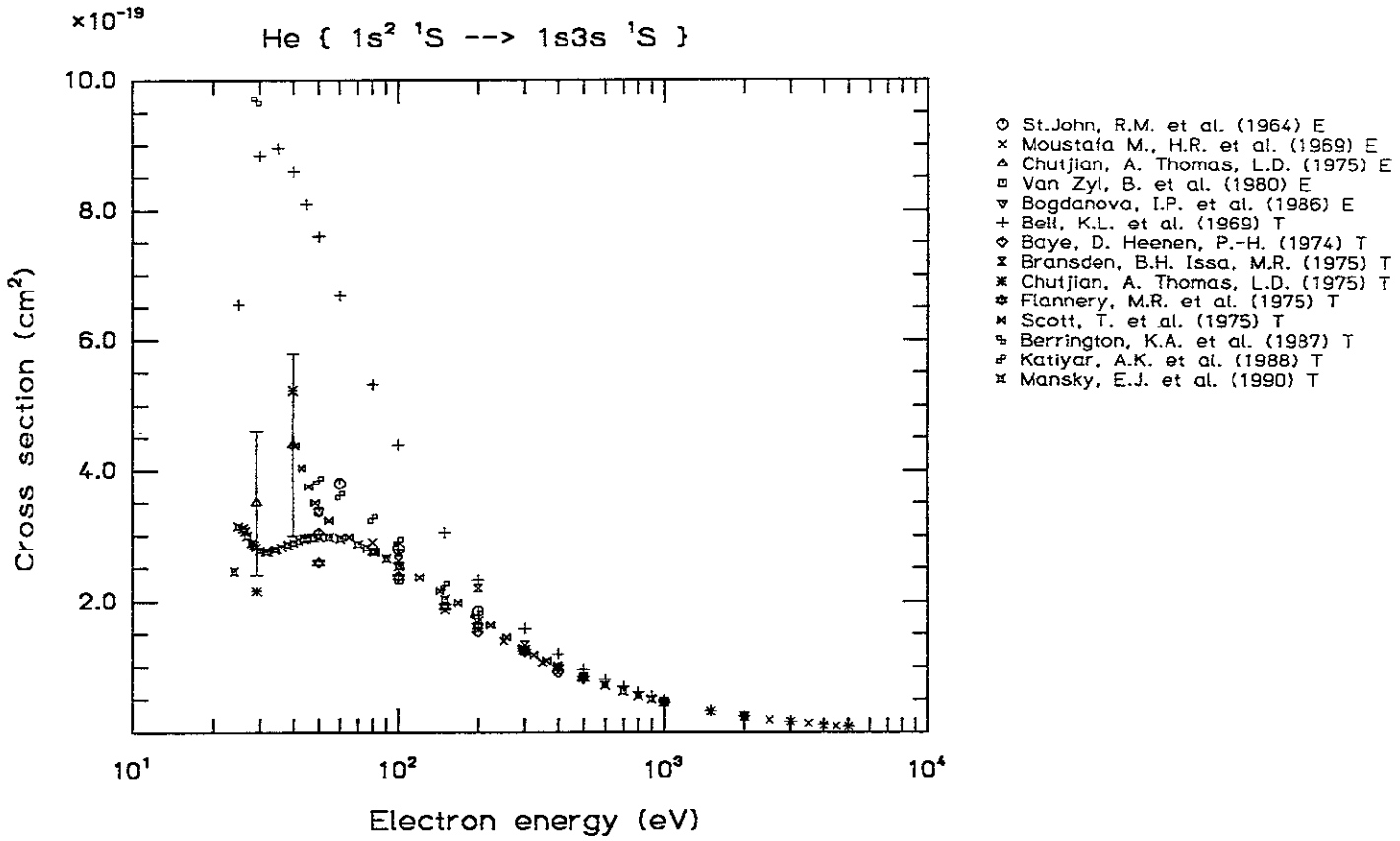
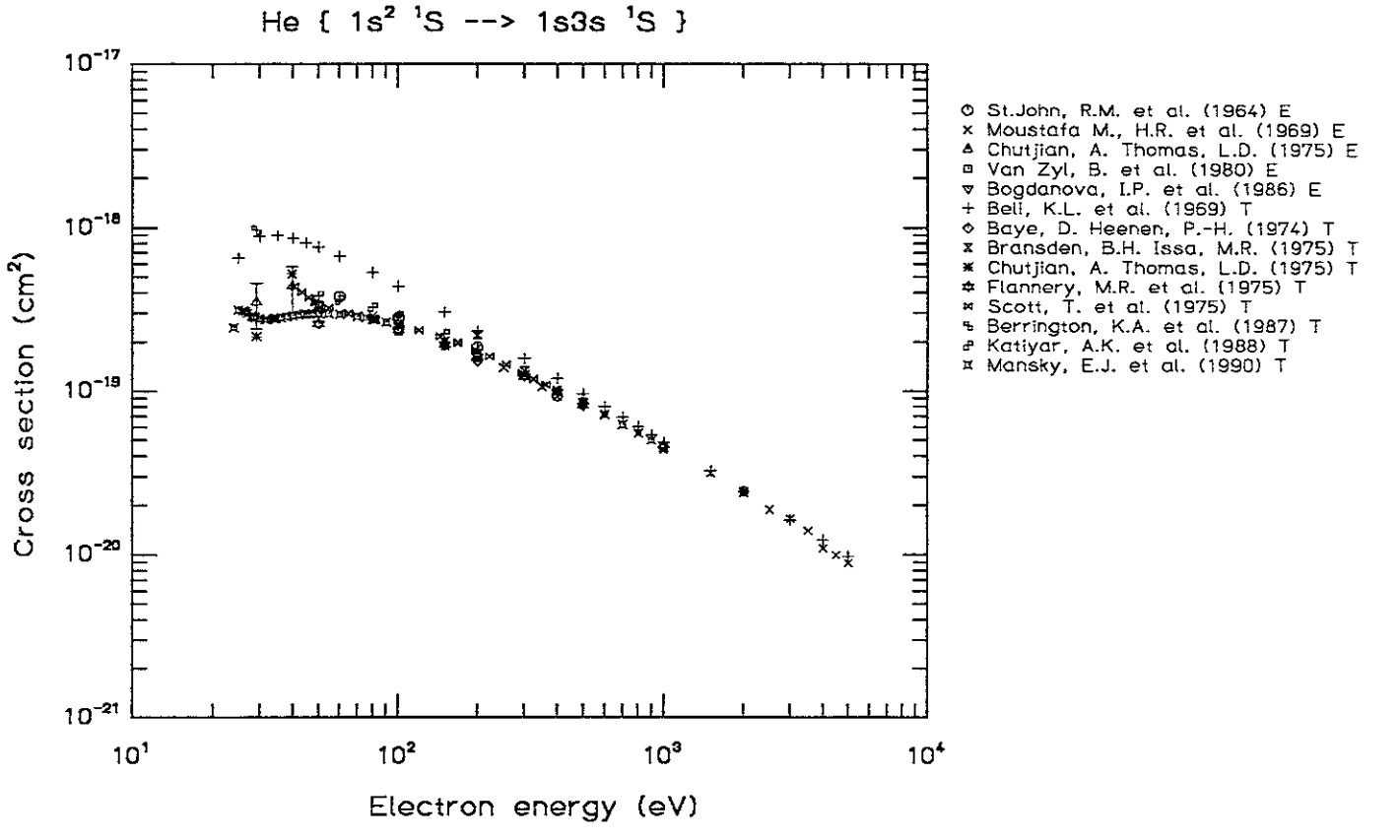
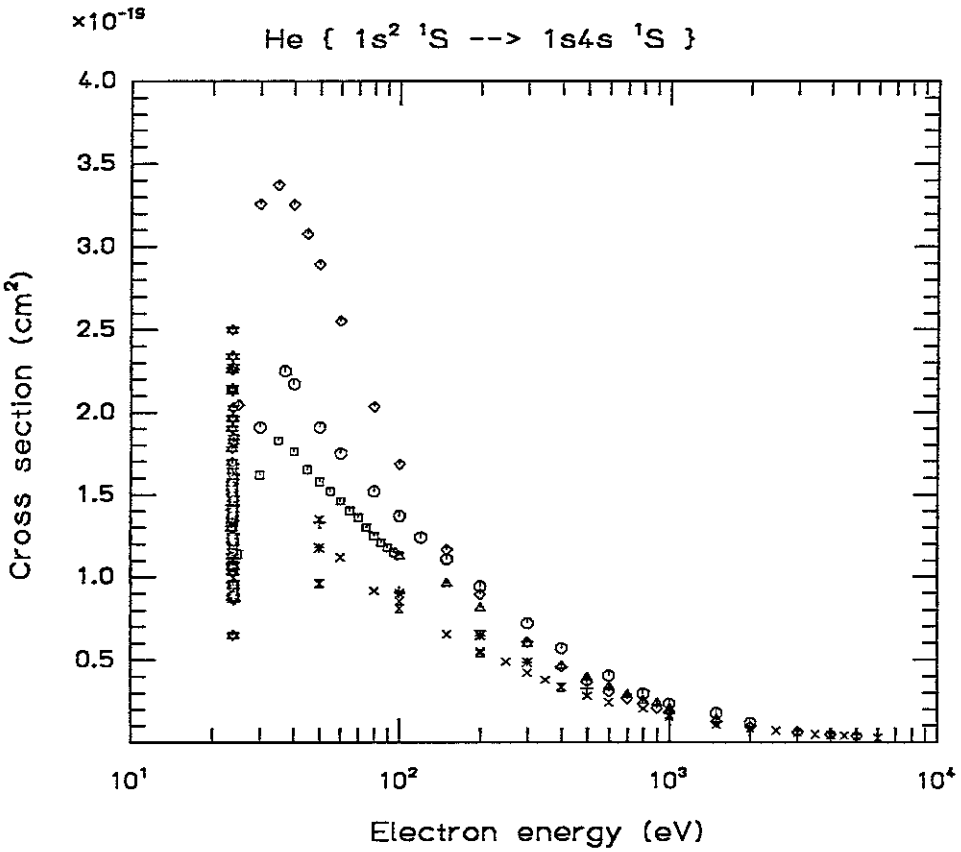
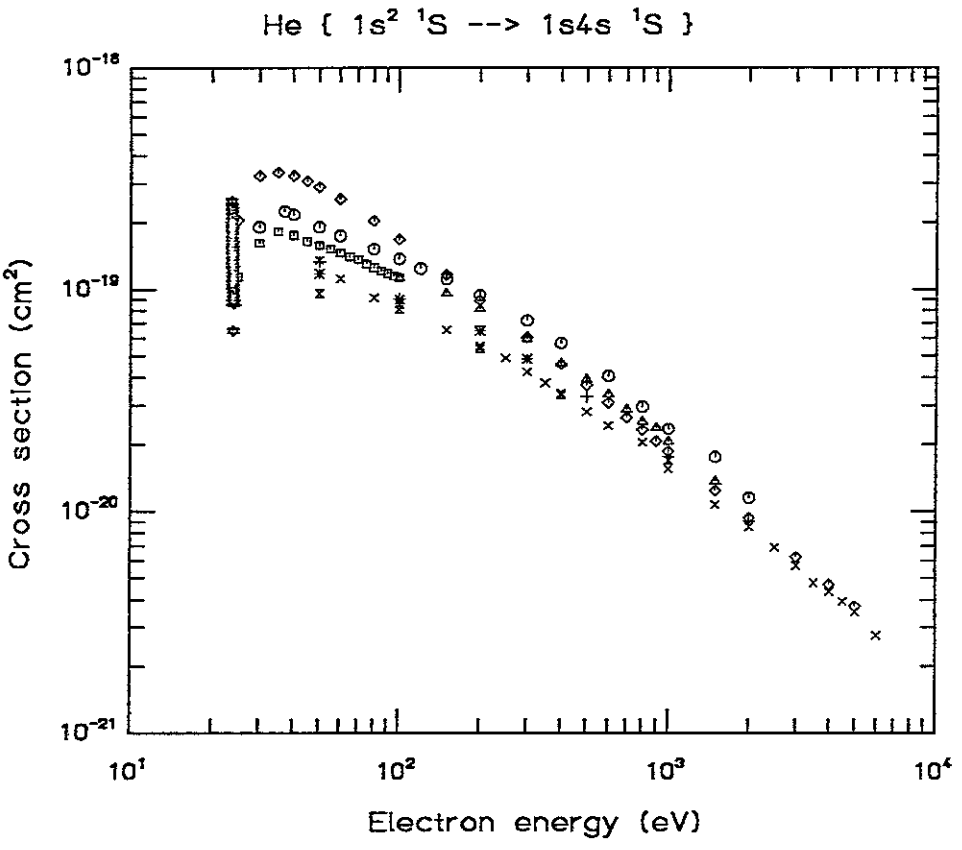
Sawey, P.M.J. et al. (1990) T


He { 1s² ¹S --> 1s3s ¹S }
×10⁻¹⁹
10.0
8.0
6.0
4.0
2.0
Cross section (cm²)
10¹
10²
10³
10⁴
Electron energy (eV)
St.John, R.M. et al. (1964) E
Moustafa M., H.R. et al. (1969) E
Chutjian, A. Thomas, L.D. (1975) E
Van Zyl, B. et al. (1980) E
Bogdanova, I.P. et al. (1986) E
Bell, K.L. et al. (1969) T
Baye, D. Heenen, P.-H. (1974) T
Bransden, B.H. Issa, M.R. (1975) T
Chutjian, A. Thomas, L.D. (1975) T
Flannery, M.R. et al. (1975) T
Scott, T. et al. (1975) T
Berrington, K.A. et al. (1987) T
Katiyar, A.K. et al. (1988) T
Mansky, E.J. et al. (1990) T

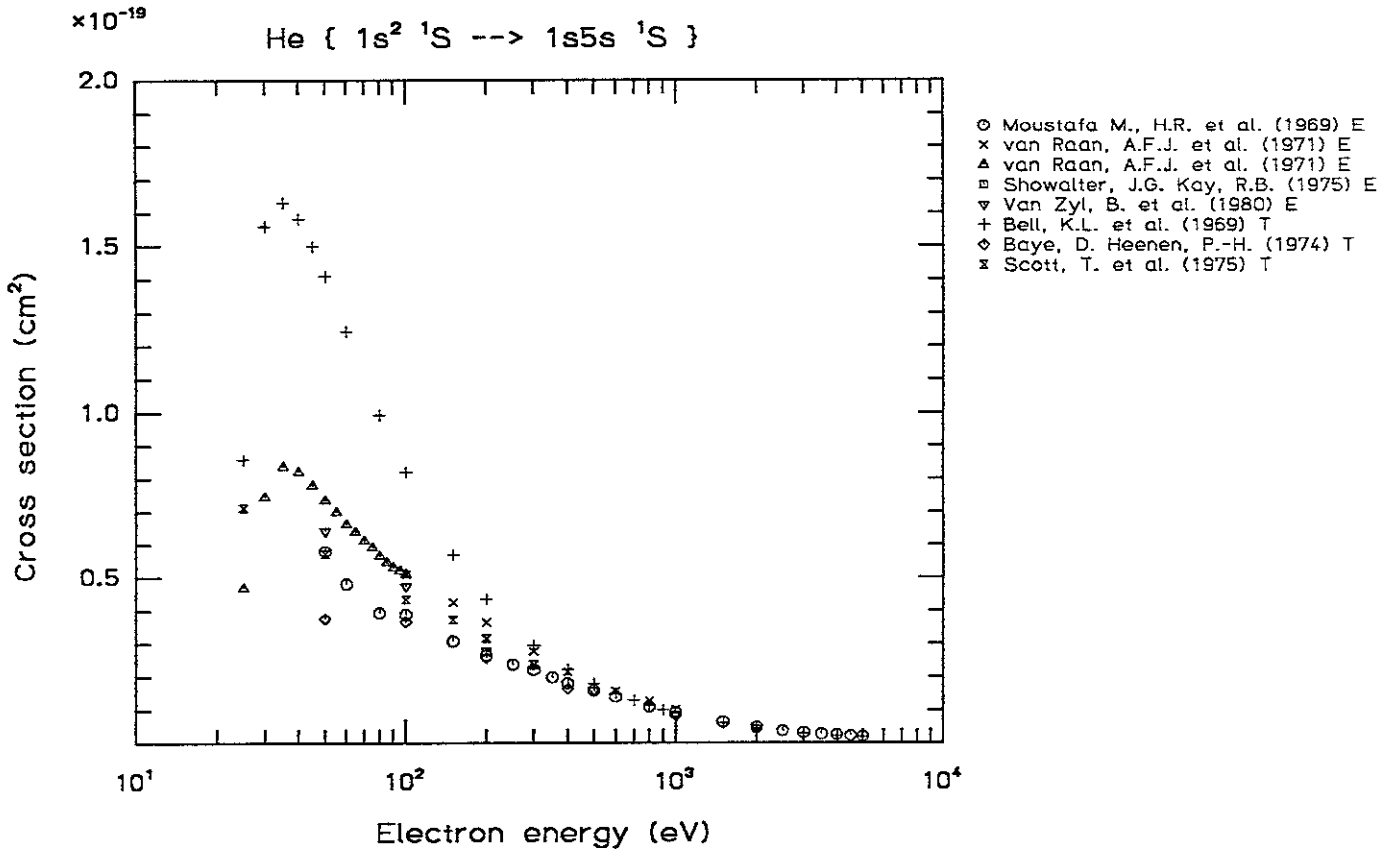

He { 1s² ¹S --> 1s3s ¹S }
10⁻¹⁷
10⁻¹⁸
10⁻¹⁹
10⁻²⁰
10⁻²¹
Cross section (cm²)
10¹
10²
10³
10⁴
Electron energy (eV)
St.John, R.M. et al. (1964) E
Moustafa M., H.R. et al. (1969) E
Chutjian, A. Thomas, L.D. (1975) E
Van Zyl, B. et al. (1980) E
Bogdanova, I.P. et al. (1986) E
Bell, K.L. et al. (1969) T
Baye, D. Heenen, P.-H. (1974) T
Bransden, B.H. Issa, M.R. (1975) T
Chutjian, A. Thomas, L.D. (1975) T
Flannery, M.R. et al. (1975) T
Scott, T. et al. (1975) T
Berrington, K.A. et al. (1987) T
Katiyar, A.K. et al. (1988) T
Mansky, E.J. et al. (1990) T

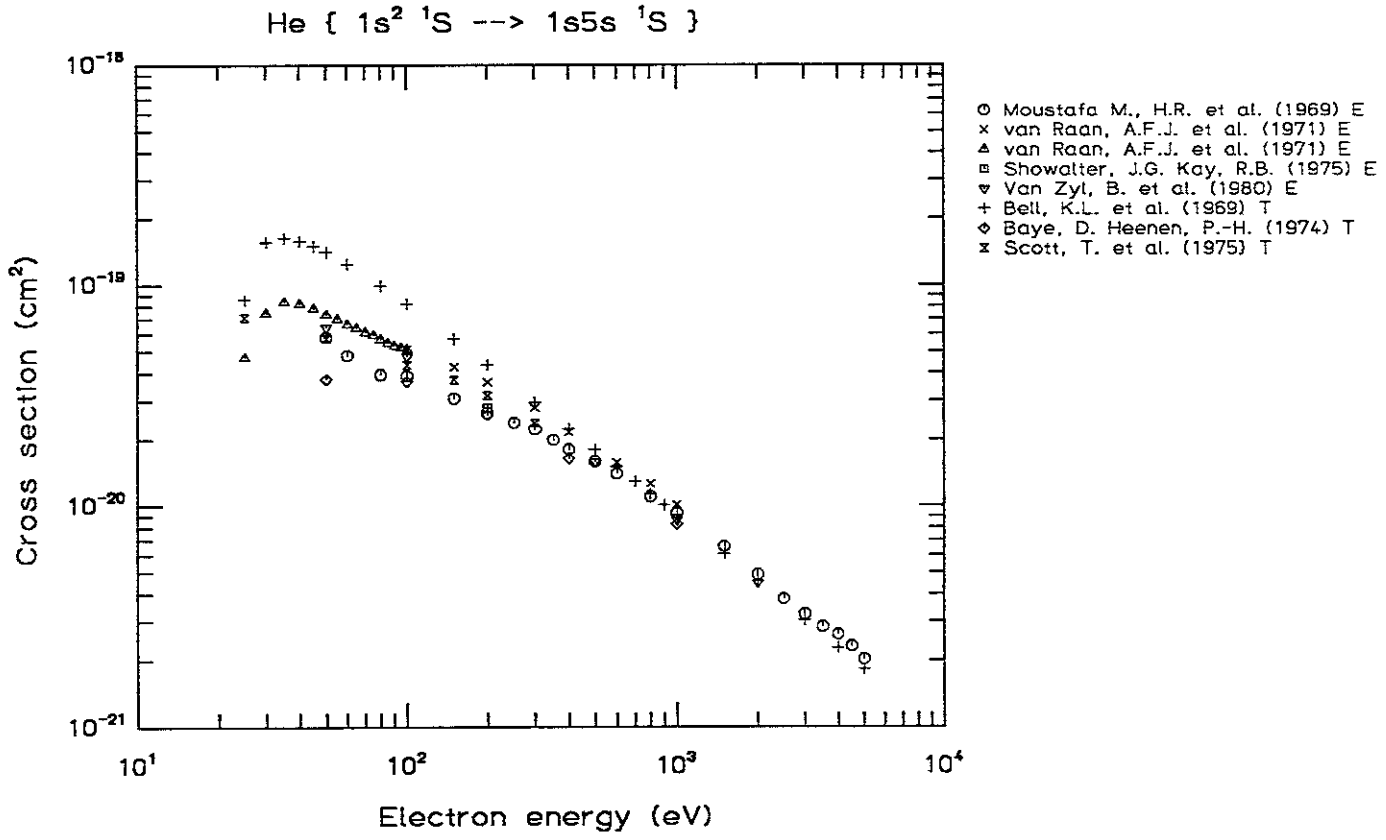


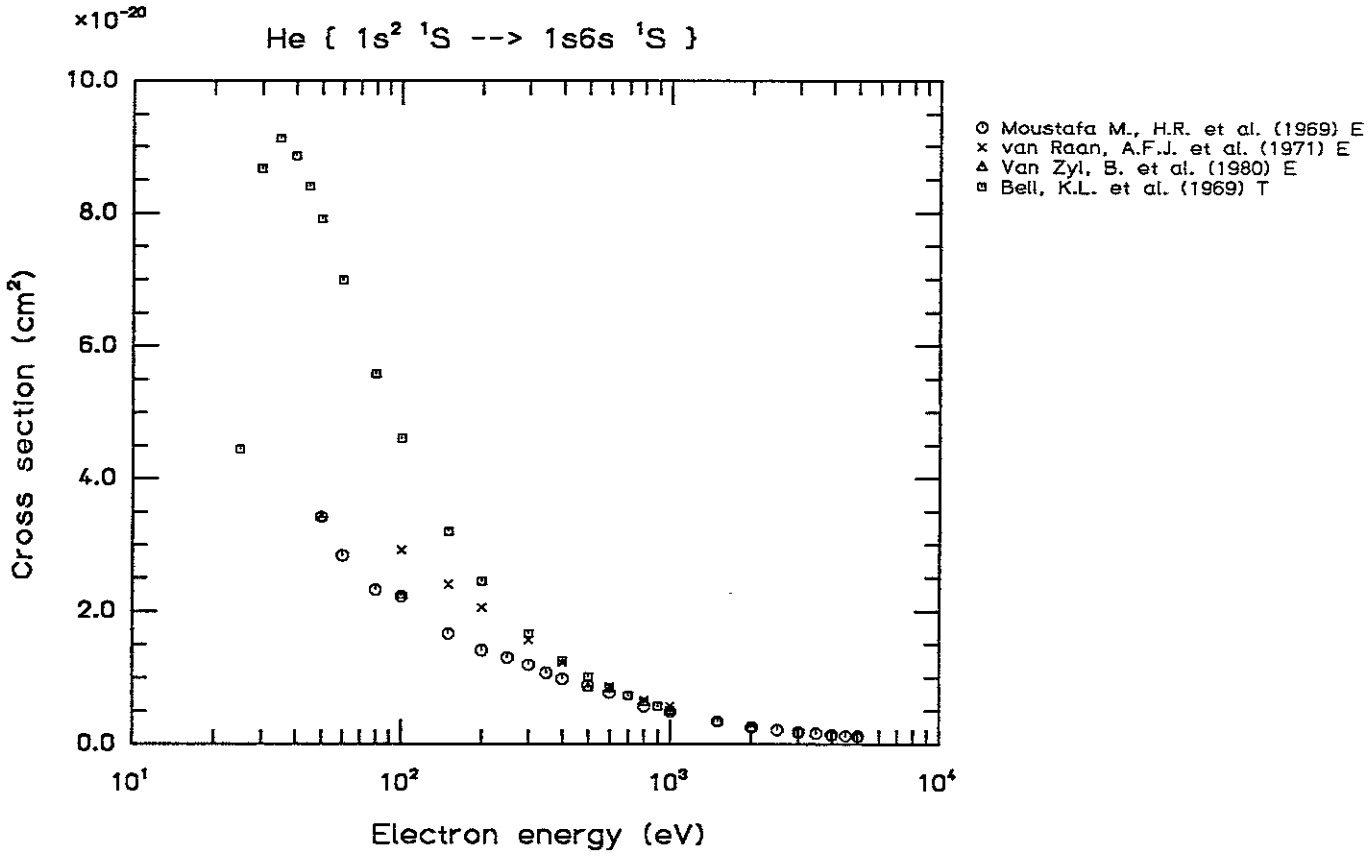

⊙ McConkey, J.W. et al. (1969) E
× Moustafa M., H.R. et al. (1969) E
△ van Raan, A.F.J. et al. (1971) E
□ van Raan, A.F.J. et al. (1971) E
▽ Showalter, J.G. Kay, R.B. (1975) E
+ Van Zyl, B. et al. (1980) E
◇ Bell, K.L. et al. (1969) T
⧗ Baye, D. Heenen, P.-H. (1974) T
✱ Scott, T. et al. (1975) T
✡ Sawey, P.M.J. et al. (1990) T

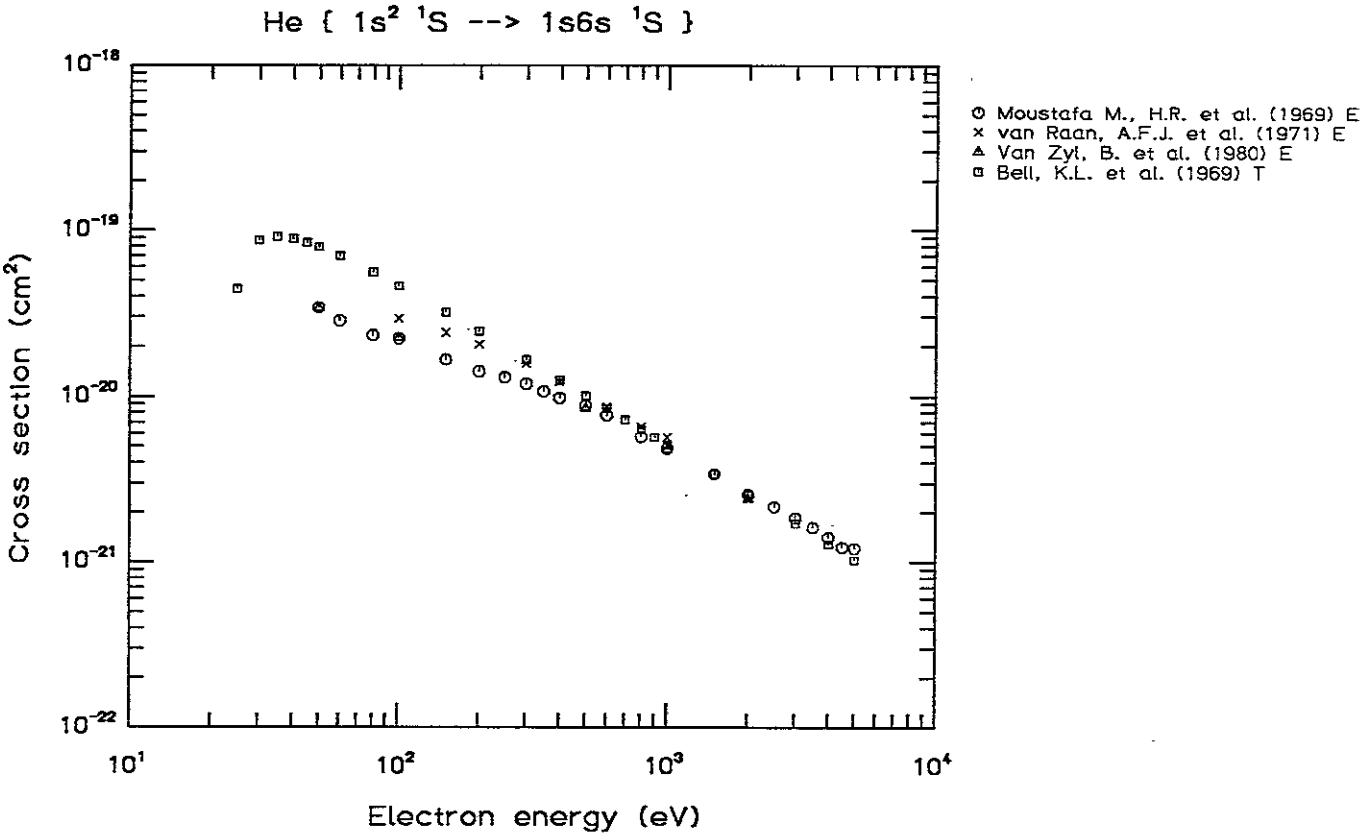


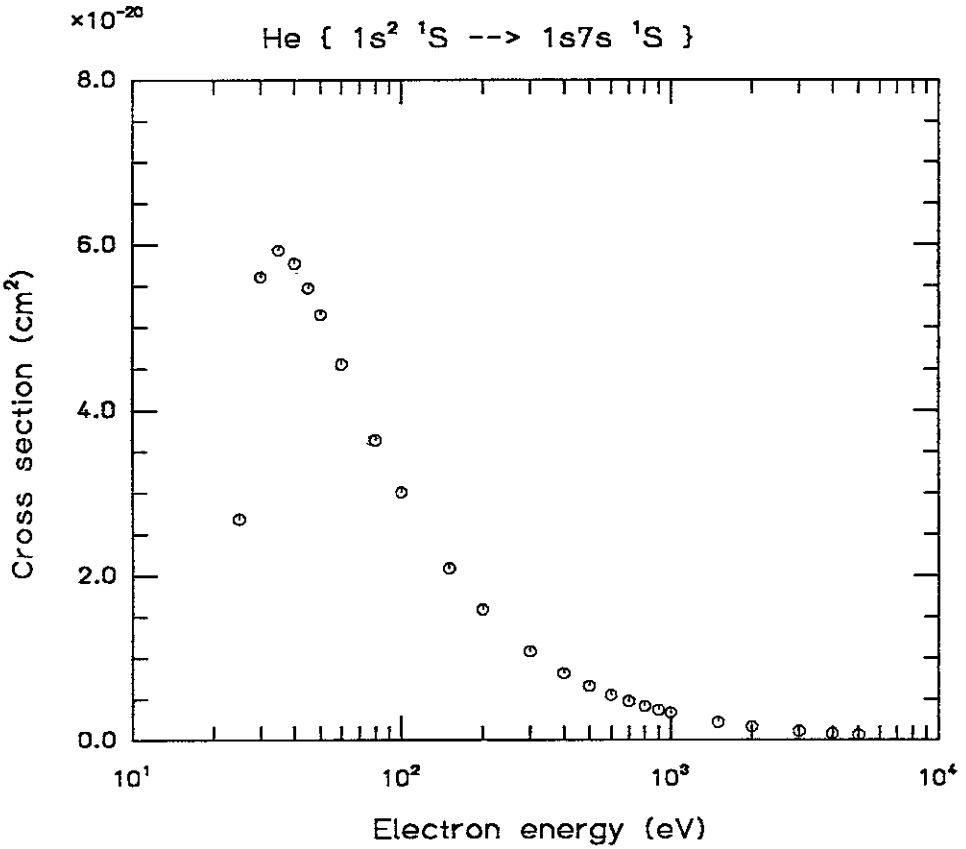

⊙ McConkey, J.W. et al. (1969) E
× Moustafa M., H.R. et al. (1969) E
△ van Raan, A.F.J. et al. (1971) E
□ van Raan, A.F.J. et al. (1971) E
▽ Showalter, J.G. Kay, R.B. (1975) E
+ Van Zyl, B. et al. (1980) E
◇ Bell, K.L. et al. (1969) T
⧗ Baye, D. Heenen, P.-H. (1974) T
✱ Scott, T. et al. (1975) T
✡ Sawey, P.M.J. et al. (1990) T


He { 1s² ¹S --> 1s5s ¹S }
×10⁻¹⁹
2.0
1.5
1.0
0.5
Cross section (cm²)
10¹
10²
10³
10⁴
Electron energy (eV)
Moustafa M., H.R. et al. (1969) E
van Raan, A.F.J. et al. (1971) E
van Raan, A.F.J. et al. (1971) E
Showalter, J.G. Kay, R.B. (1975) E
Van Zyl, B. et al. (1980) E
Bell, K.L. et al. (1969) T
Baye, D. Heenen, P.-H. (1974) T
Scott, T. et al. (1975) T

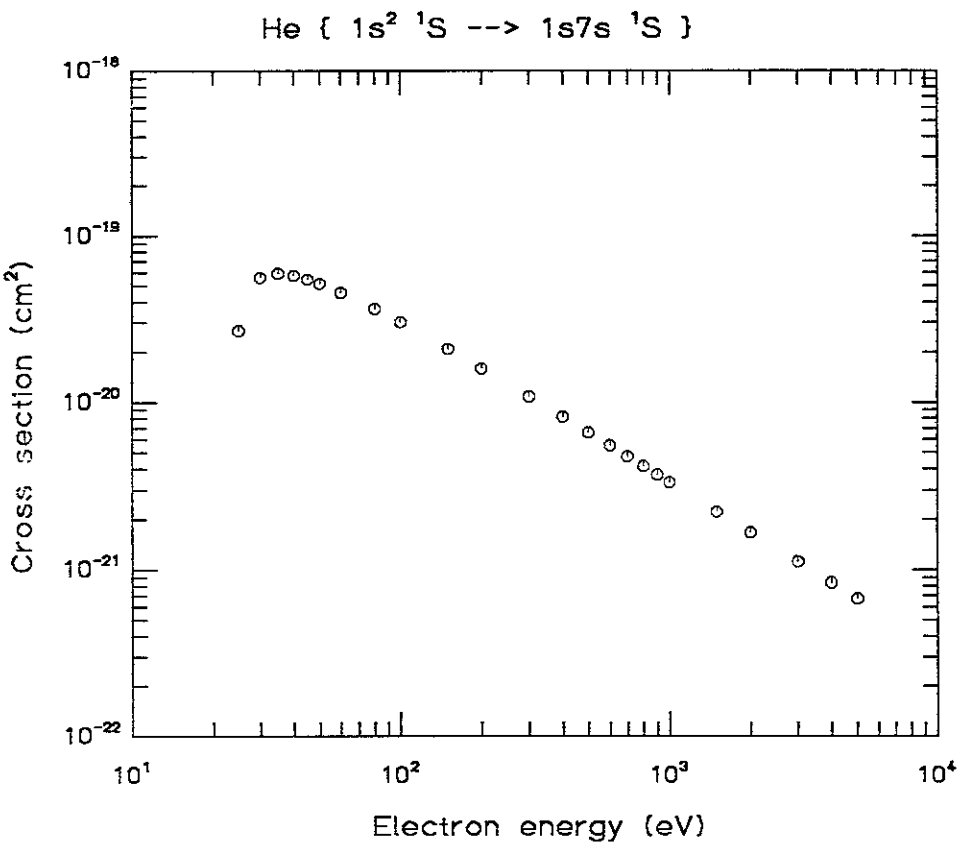

He { 1s² ¹S --> 1s5s ¹S }
10⁻¹⁸
10⁻¹⁹
10⁻²⁰
10⁻²¹
Cross section (cm²)
10¹
10²
10³
10⁴
Electron energy (eV)
Moustafa M., H.R. et al. (1969) E
van Raan, A.F.J. et al. (1971) E
van Raan, A.F.J. et al. (1971) E
Showalter, J.G. Kay, R.B. (1975) E
Van Zyl, B. et al. (1980) E
Bell, K.L. et al. (1969) T
Baye, D. Heenen, P.-H. (1974) T
Scott, T. et al. (1975) T


He { 1s² ¹S --> 1s6s ¹S }
×10⁻²⁰
10.0
8.0
6.0
4.0
2.0
0.0
Cross section (cm²)
10¹
10²
10³
10⁴
Electron energy (eV)
Moustafa M., H.R. et al. (1969) E
van Raan, A.F.J. et al. (1971) E
Van Zyl, B. et al. (1980) E
Bell, K.L. et al. (1969) T

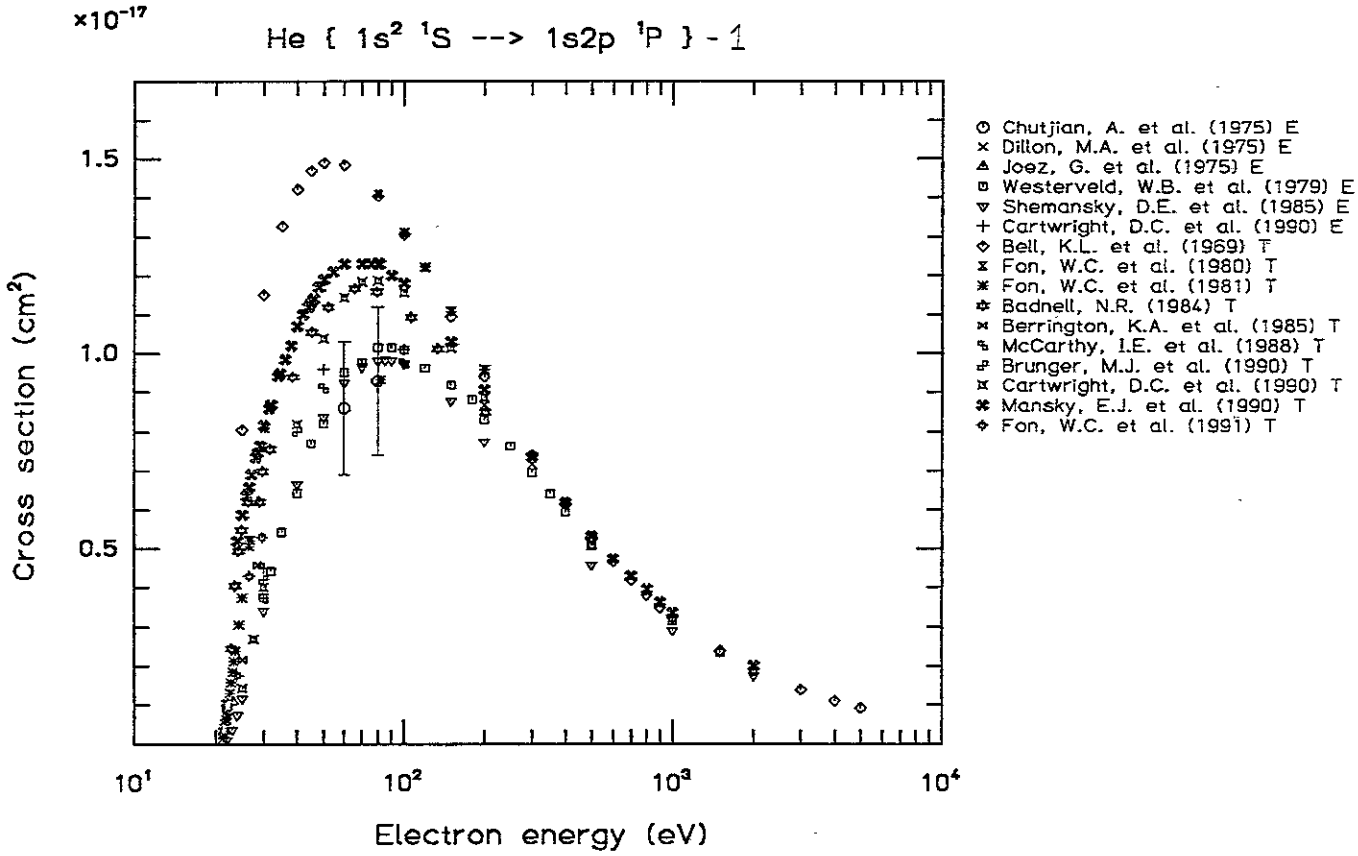

He { 1s² ¹S --> 1s6s ¹S }
10⁻¹⁸
10⁻¹⁹
10⁻²⁰
10⁻²¹
10⁻²²
Cross section (cm²)
10¹
10²
10³
10⁴
Electron energy (eV)
Moustafa M., H.R. et al. (1969) E
van Raan, A.F.J. et al. (1971) E
Van Zyl, B. et al. (1980) E
Bell, K.L. et al. (1969) T

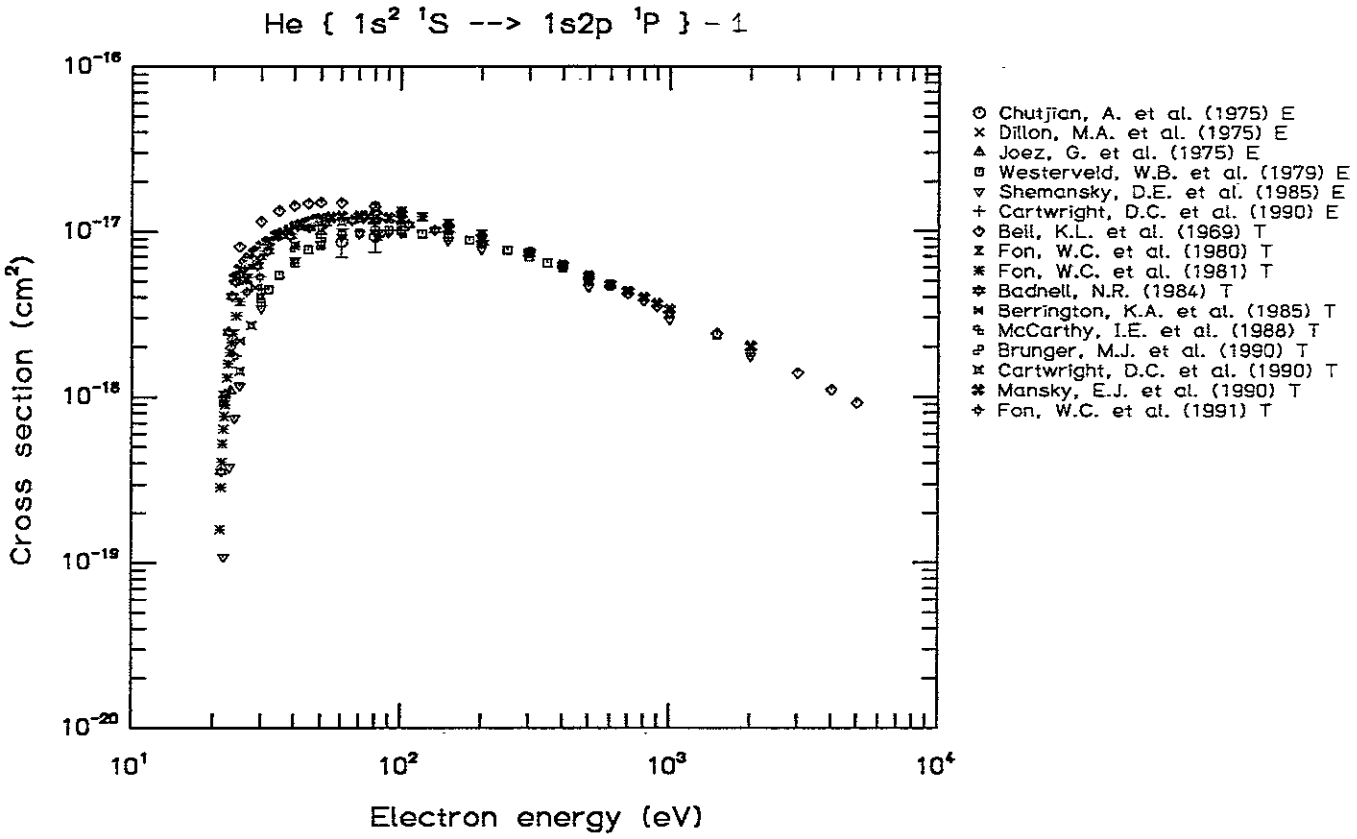



⊙ Bell, K.L. et al. (1969) T




⊙ Bell, K.L. et al. (1969) T


He { 1s² ¹S --> 1s2p ¹P } - 1
×10⁻¹⁷
Cross section (cm²)
Electron energy (eV)
Chutjian, A. et al. (1975) E
Dillon, M.A. et al. (1975) E
Joez, G. et al. (1975) E
Westerveld, W.B. et al. (1979) E
Shemansky, D.E. et al. (1985) E
Cartwright, D.C. et al. (1990) E
Bell, K.L. et al. (1969) T
Fon, W.C. et al. (1980) T
Fon, W.C. et al. (1981) T
Badnell, N.R. (1984) T
Berrington, K.A. et al. (1985) T
McCarthy, I.E. et al. (1988) T
Brunger, M.J. et al. (1990) T
Cartwright, D.C. et al. (1990) T
Mansky, E.J. et al. (1990) T
Fon, W.C. et al. (1991) T


He { 1s² ¹S --> 1s2p ¹P } - 1
Cross section (cm²)
Electron energy (eV)
Chutjian, A. et al. (1975) E
Dillon, M.A. et al. (1975) E
Joez, G. et al. (1975) E
Westerveld, W.B. et al. (1979) E
Shemansky, D.E. et al. (1985) E
Cartwright, D.C. et al. (1990) E
Bell, K.L. et al. (1969) T
Fon, W.C. et al. (1980) T
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Badnell, N.R. (1984) T
Berrington, K.A. et al. (1985) T
McCarthy, I.E. et al. (1988) T
Brunger, M.J. et al. (1990) T
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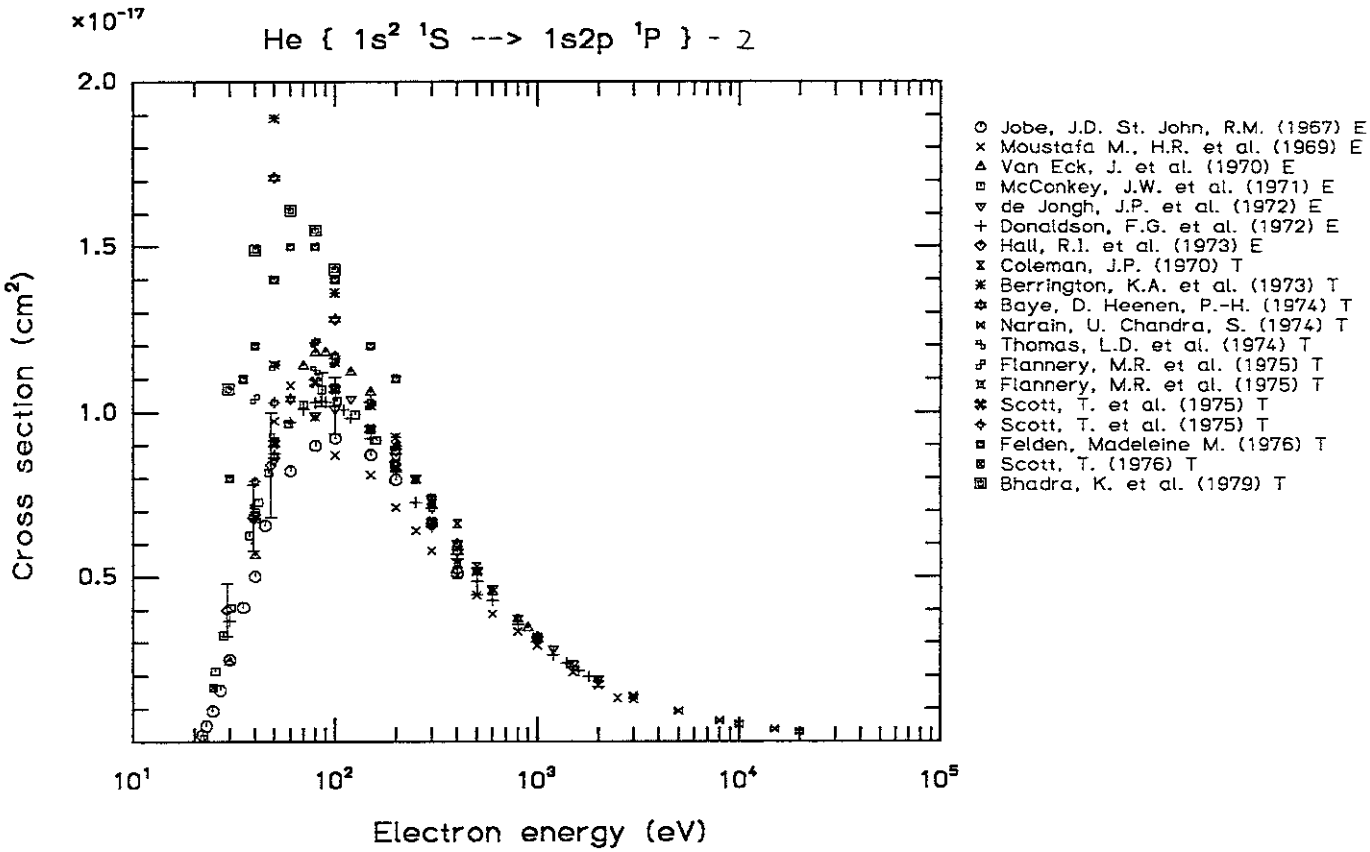
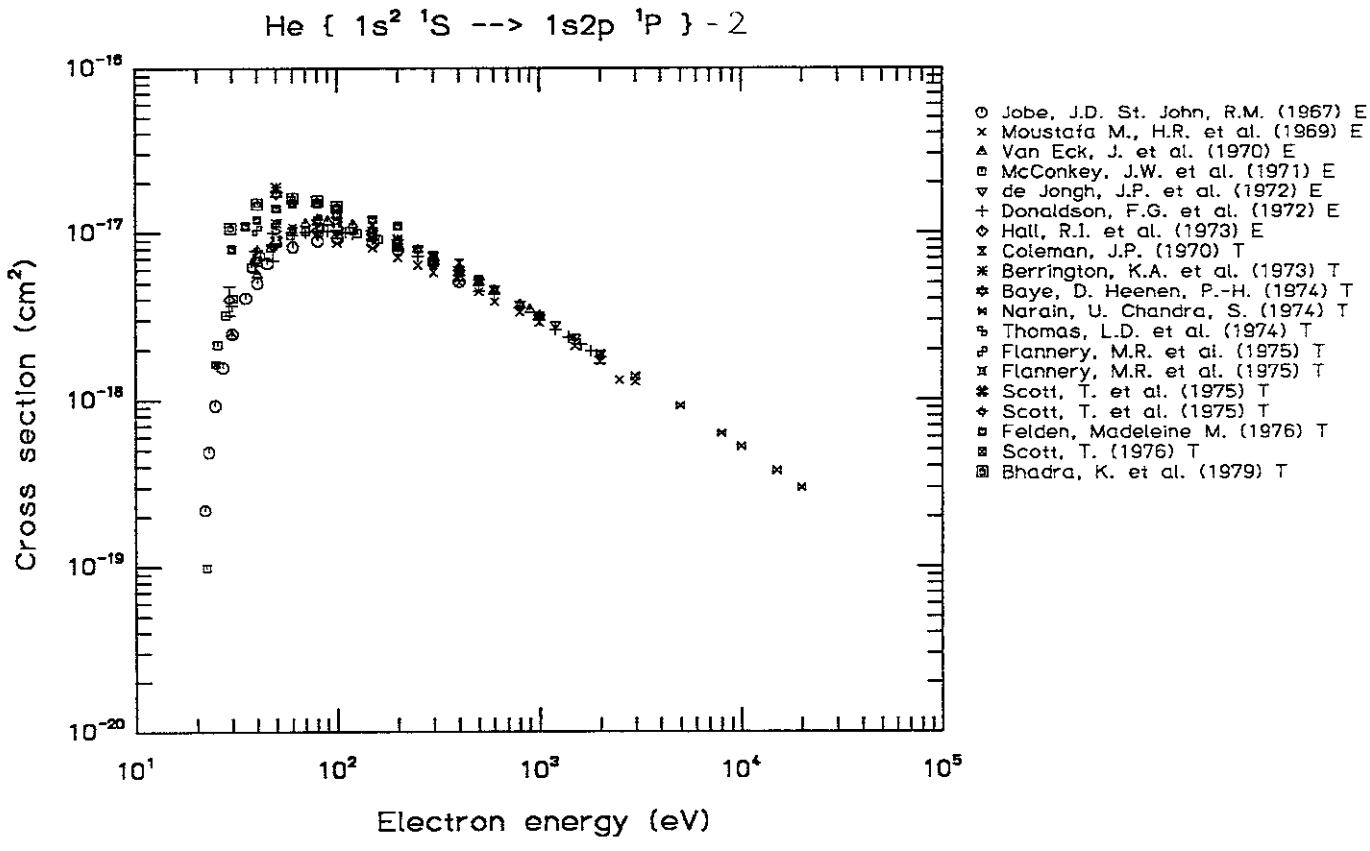

×10⁻¹⁷
He { 1s² ¹S --> 1s2p ¹P } - 2
2.0
1.5
1.0
0.5
Cross section (cm²)
10¹
10²
10³
10⁴
10⁵
Electron energy (eV)
Jobe, J.D. St. John, R.M. (1967) E
Moustafa M., H.R. et al. (1969) E
Van Eck, J. et al. (1970) E
McConkey, J.W. et al. (1971) E
de Jongh, J.P. et al. (1972) E
Donaldson, F.G. et al. (1972) E
Hall, R.I. et al. (1973) E
Coleman, J.P. (1970) T
Berrington, K.A. et al. (1973) T
Baye, D. Heenen, P.-H. (1974) T
Narain, U. Chandra, S. (1974) T
Thomas, L.D. et al. (1974) T
Flannery, M.R. et al. (1975) T
Flannery, M.R. et al. (1975) T
Scott, T. et al. (1975) T
Scott, T. et al. (1975) T
Felden, Madeleine M. (1976) T
Scott, T. (1976) T
Bhadra, K. et al. (1979) T


He { 1s² ¹S --> 1s2p ¹P } - 2
10⁻¹⁶
10⁻¹⁷
10⁻¹⁸
10⁻¹⁹
10⁻²⁰
Cross section (cm²)
10¹
10²
10³
10⁴
10⁵
Electron energy (eV)
Jobe, J.D. St. John, R.M. (1967) E
Moustafa M., H.R. et al. (1969) E
Van Eck, J. et al. (1970) E
McConkey, J.W. et al. (1971) E
de Jongh, J.P. et al. (1972) E
Donaldson, F.G. et al. (1972) E
Hall, R.I. et al. (1973) E
Coleman, J.P. (1970) T
Berrington, K.A. et al. (1973) T
Baye, D. Heenen, P.-H. (1974) T
Narain, U. Chandra, S. (1974) T
Thomas, L.D. et al. (1974) T
Flannery, M.R. et al. (1975) T
Flannery, M.R. et al. (1975) T
Scott, T. et al. (1975) T
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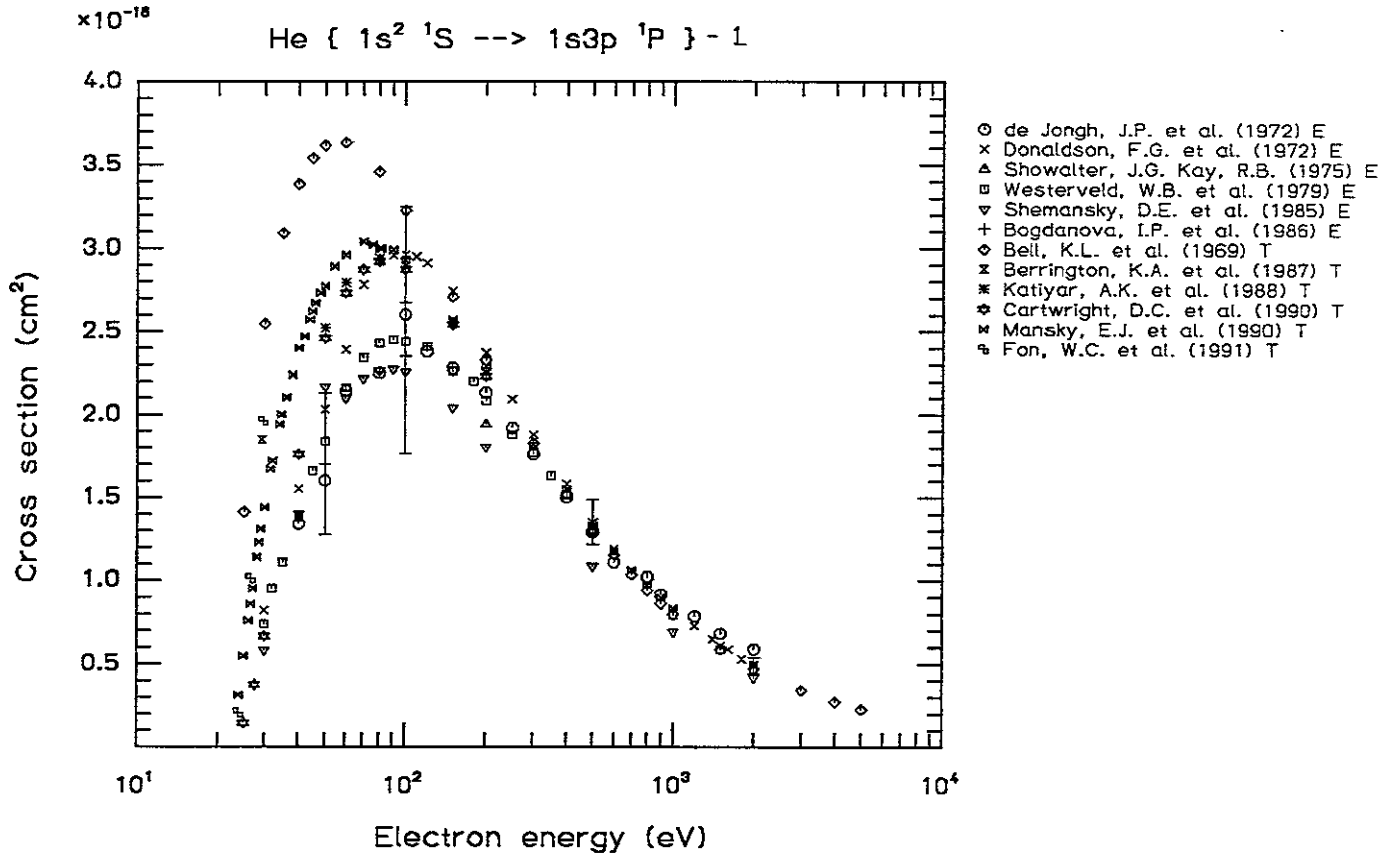
Scott, T. (1976) T
Bhadra, K. et al. (1979) T


He { 1s² ¹S --> 1s3p ¹P } - 1
×10⁻¹⁸
Cross section (cm²)
Electron energy (eV)
de Jongh, J.P. et al. (1972) E
Donaldson, F.G. et al. (1972) E
Showalter, J.G. Kay, R.B. (1975) E
Westerveld, W.B. et al. (1979) E
Shemansky, D.E. et al. (1985) E
Bogdanova, I.P. et al. (1986) E
Bell, K.L. et al. (1969) T
Berrington, K.A. et al. (1987) T
Katiyar, A.K. et al. (1988) T
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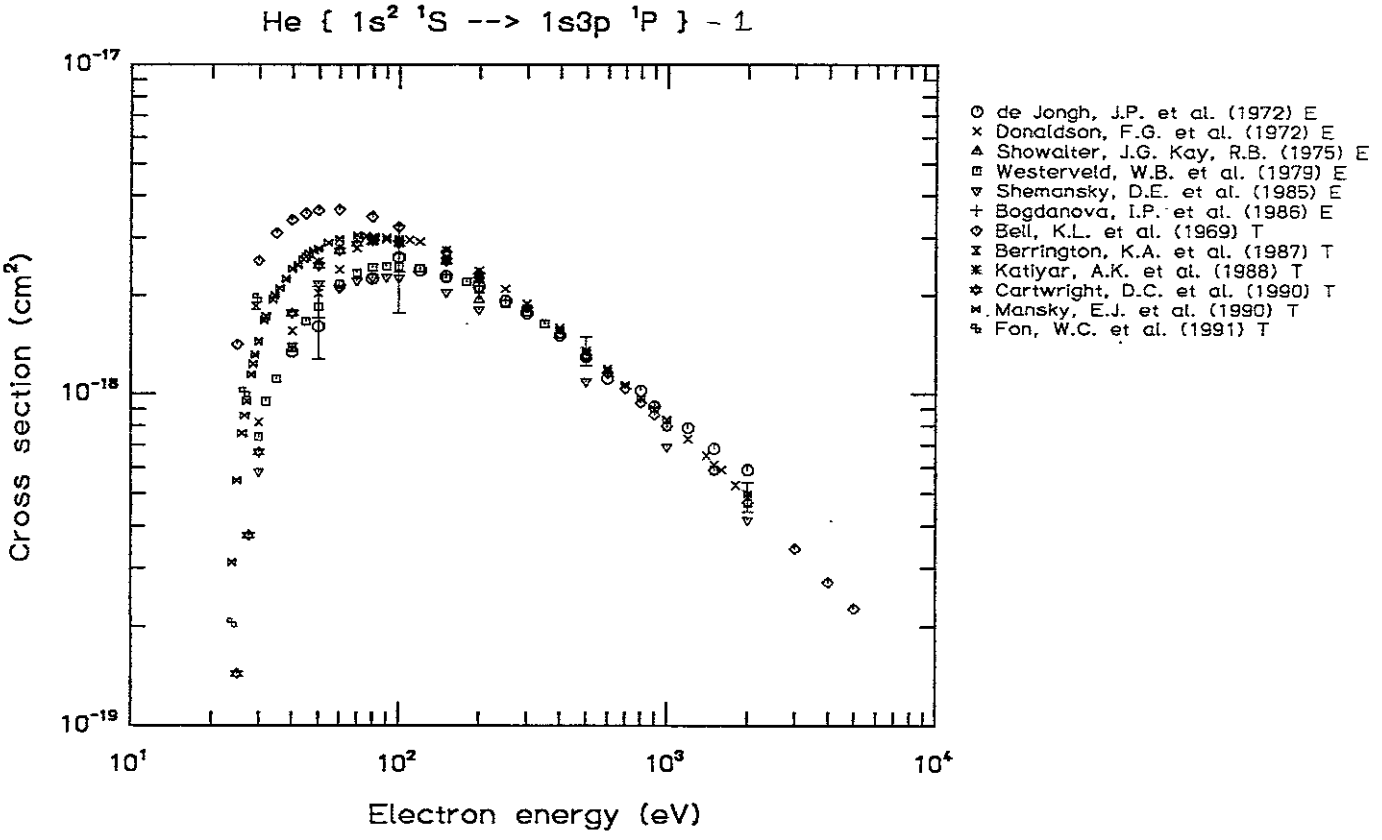
He { 1s² ¹S --> 1s3p ¹P } - 1
Cross section (cm²)
Electron energy (eV)
de Jongh, J.P. et al. (1972) E
Donaldson, F.G. et al. (1972) E
Showalter, J.G. Kay, R.B. (1975) E
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Bell, K.L. et al. (1969) T
Berrington, K.A. et al. (1987) T
Katiyar, A.K. et al. (1988) T
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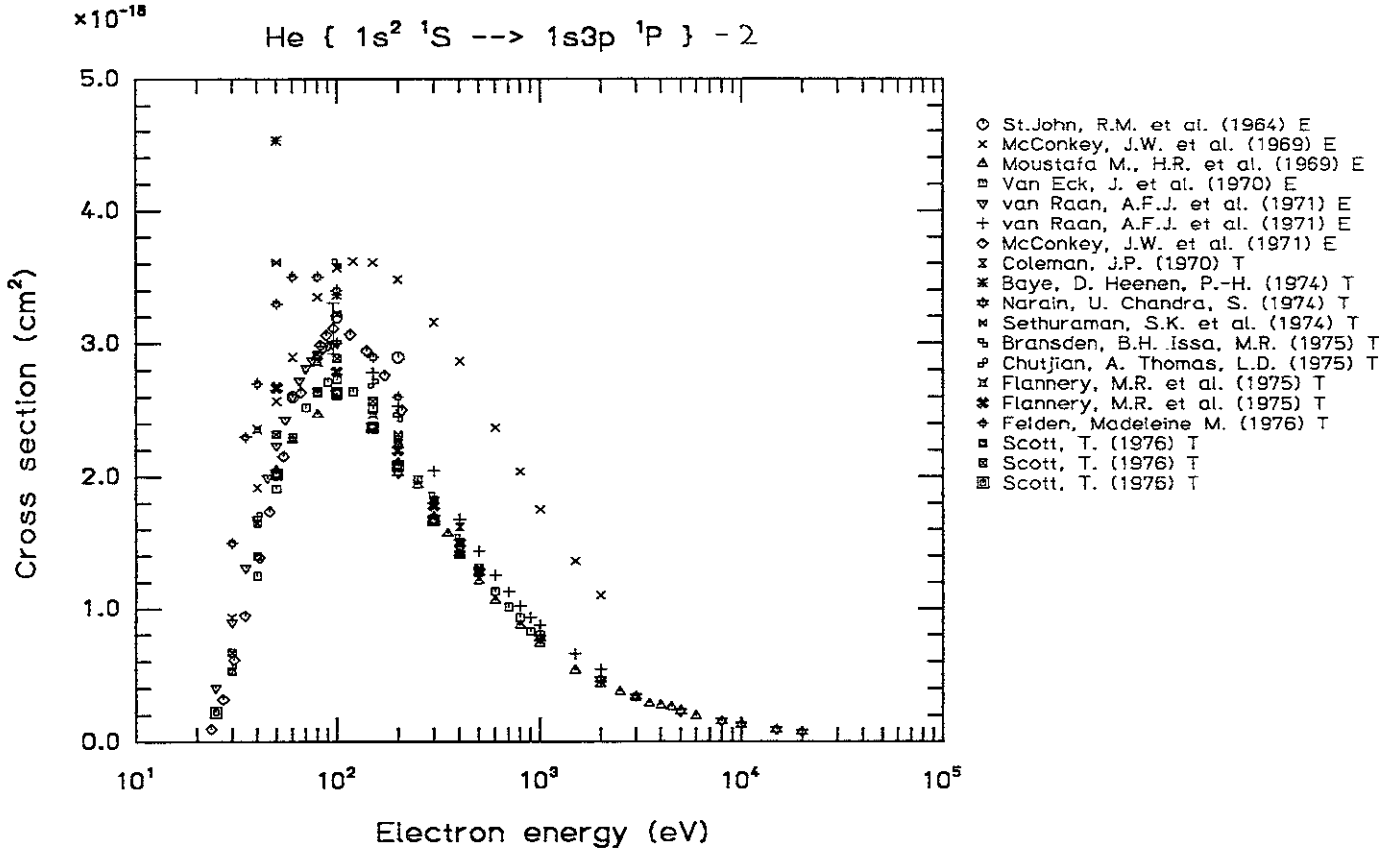
×10⁻¹⁸
He { 1s² ¹S --> 1s3p ¹P } - 2
Cross section (cm²)
Electron energy (eV)
St.John, R.M. et al. (1964) E
McConkey, J.W. et al. (1969) E
Moustafa M., H.R. et al. (1969) E
Van Eck, J. et al. (1970) E
van Raan, A.F.J. et al. (1971) E
van Raan, A.F.J. et al. (1971) E
McConkey, J.W. et al. (1971) E
Coleman, J.P. (1970) T
Baye, D. Heenen, P.-H. (1974) T
Narain, U. Chandra, S. (1974) T
Sethuraman, S.K. et al. (1974) T
Bransden, B.H. Issa, M.R. (1975) T
Chutjian, A. Thomas, L.D. (1975) T
Flannery, M.R. et al. (1975) T
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Felden, Madeleine M. (1976) T
Scott, T. (1976) T
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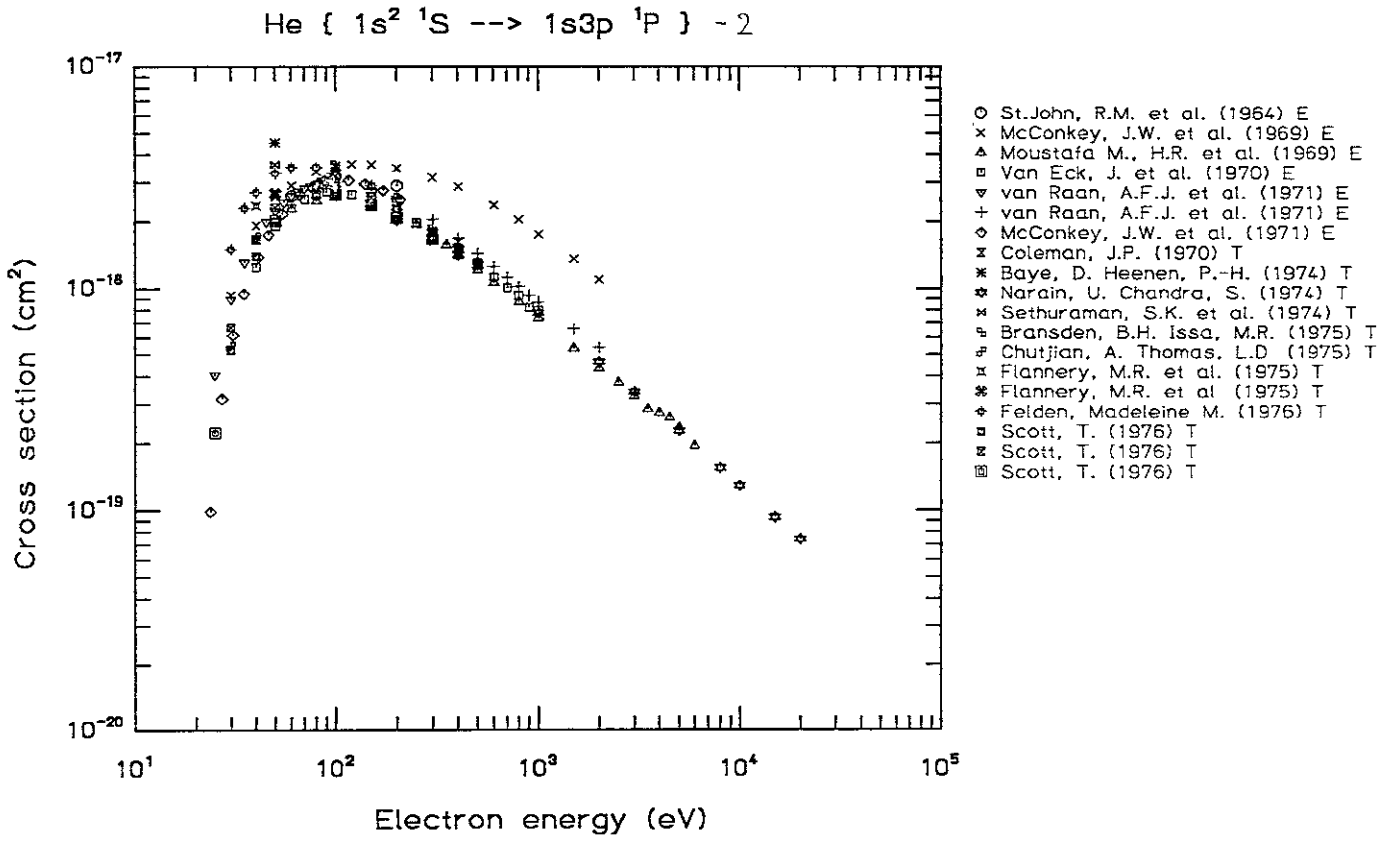
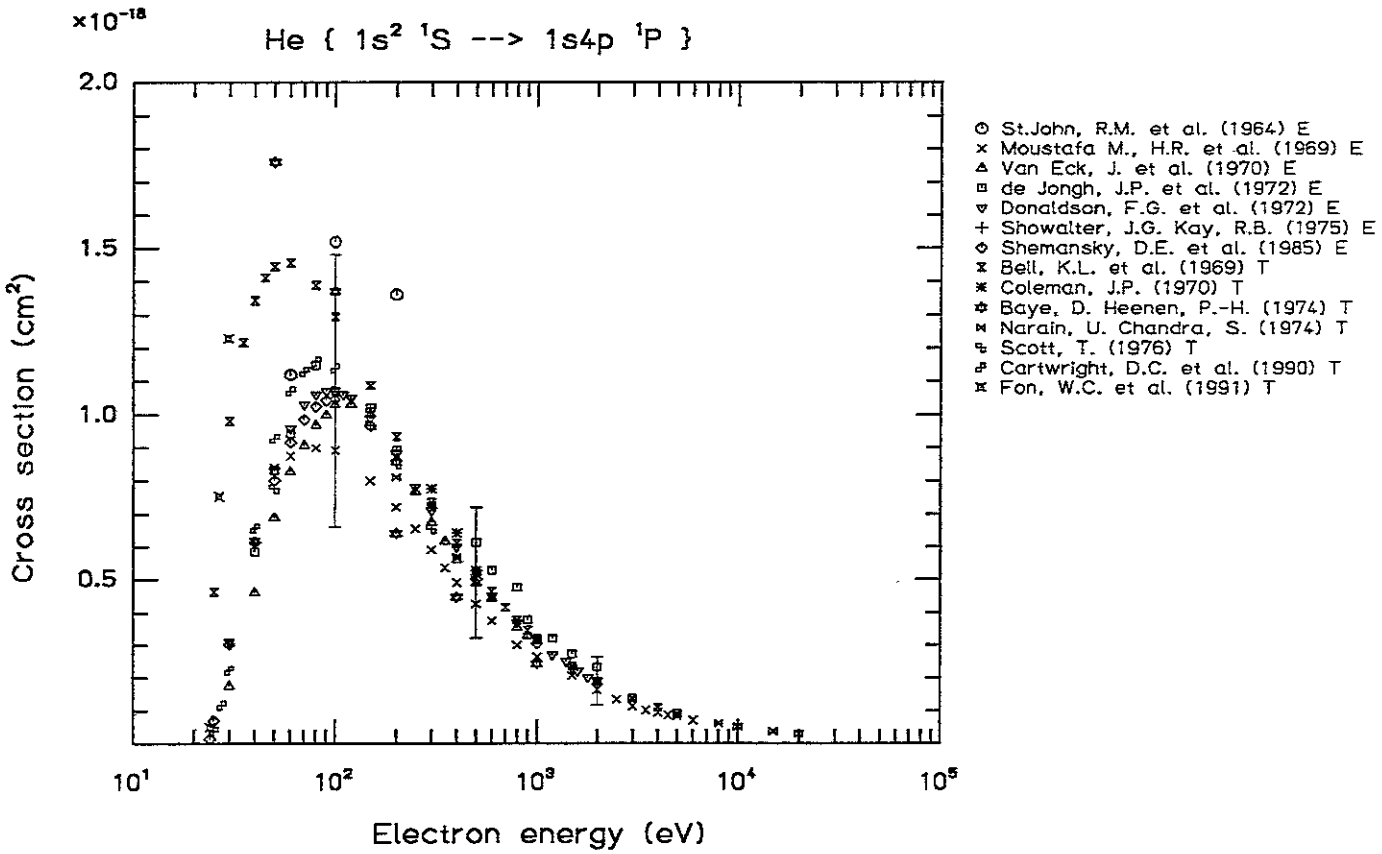
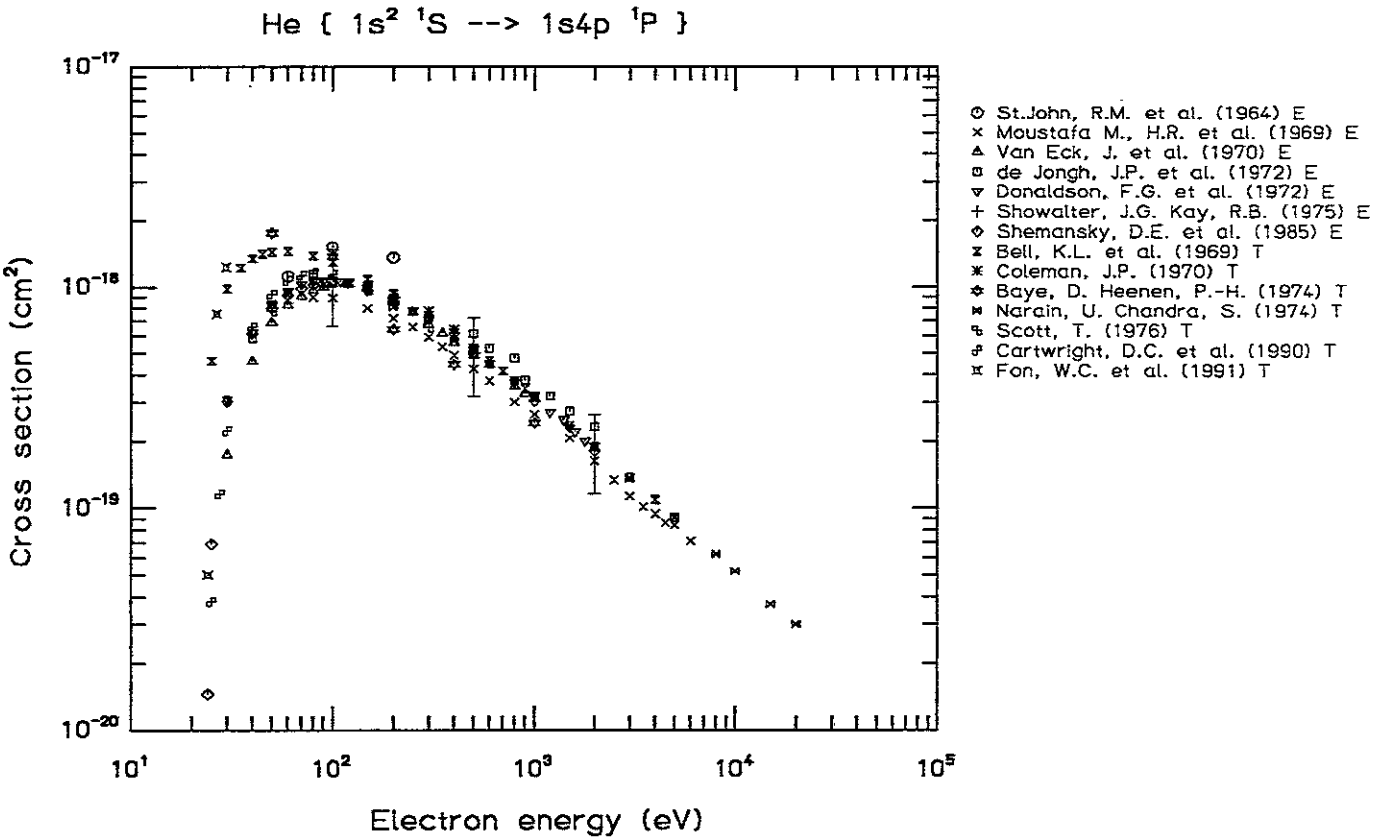
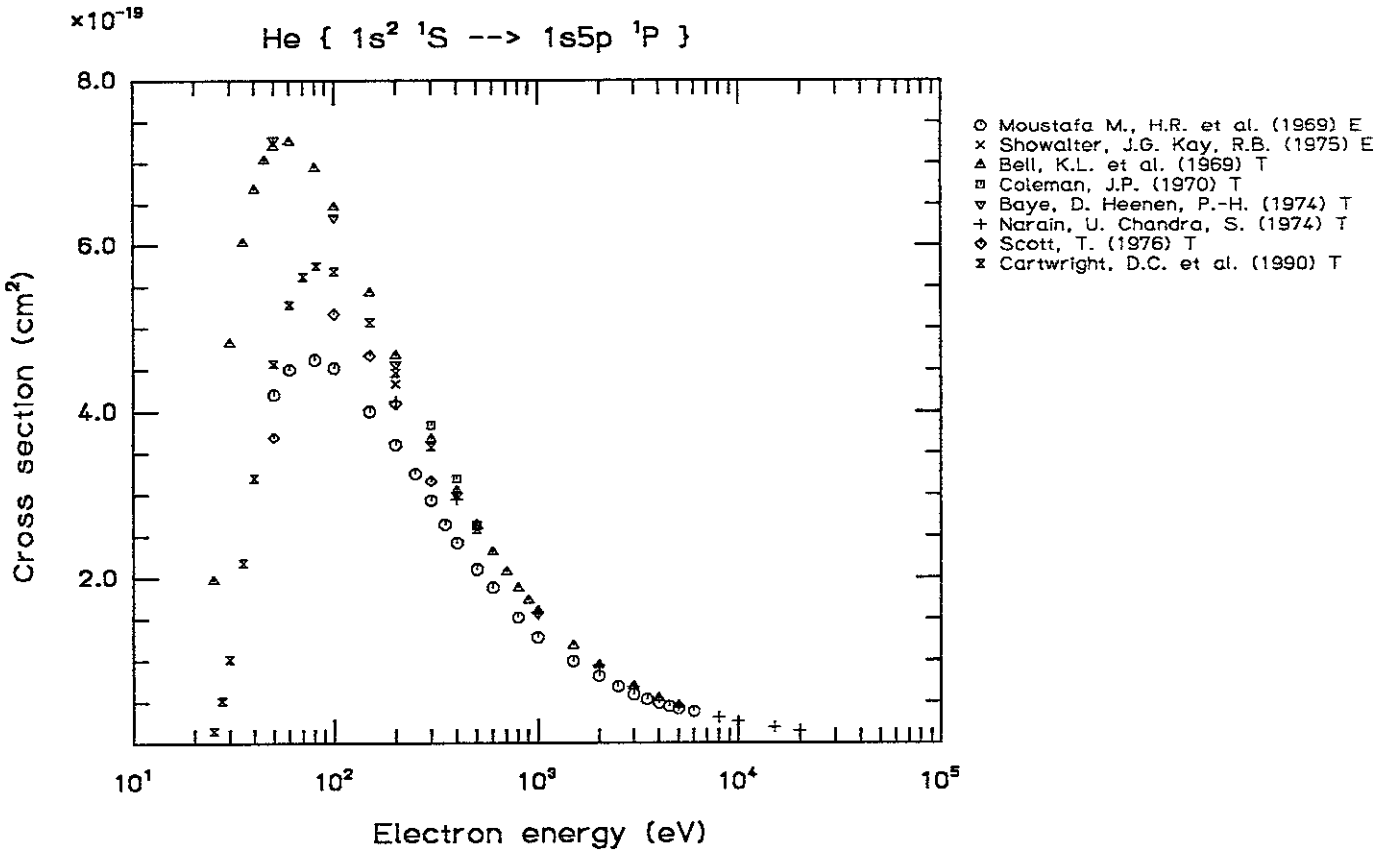
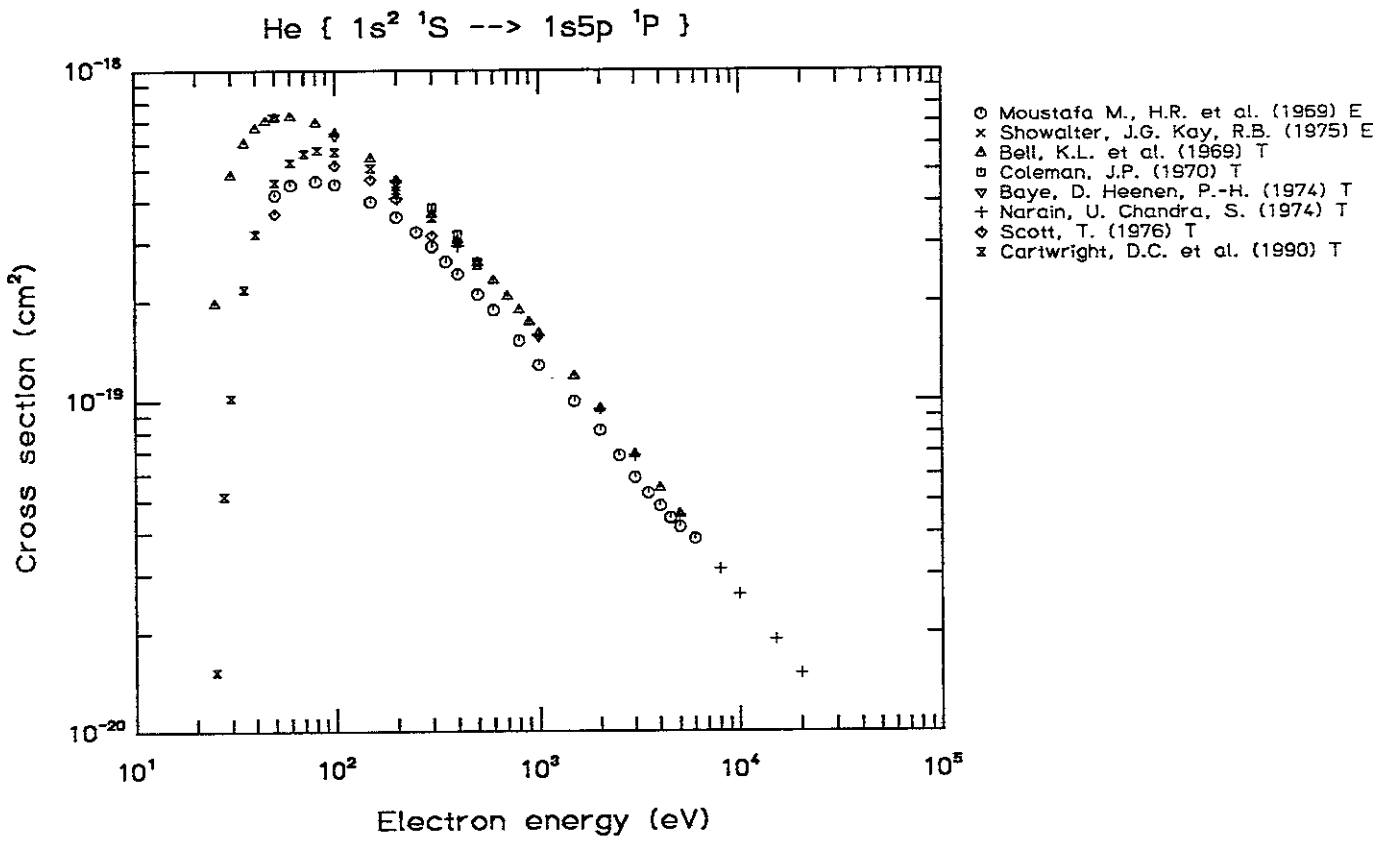
Scott, T. (1976) T

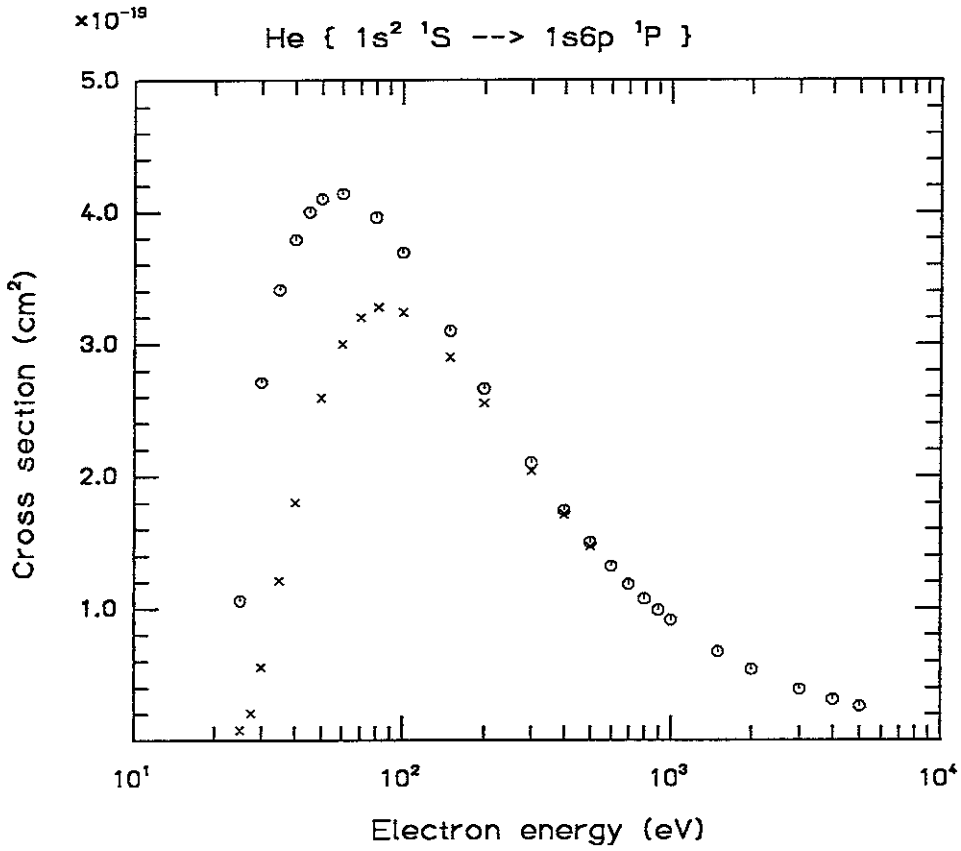

He { 1s² ¹S --> 1s3p ¹P } - 2
Cross section (cm²)
Electron energy (eV)
St.John, R.M. et al. (1964) E
McConkey, J.W. et al. (1969) E
Moustafa M., H.R. et al. (1969) E
Van Eck, J. et al. (1970) E
van Raan, A.F.J. et al. (1971) E
van Raan, A.F.J. et al. (1971) E
McConkey, J.W. et al. (1971) E
Coleman, J.P. (1970) T
Baye, D. Heenen, P.-H. (1974) T
Narain, U. Chandra, S. (1974) T
Sethuraman, S.K. et al. (1974) T
Bransden, B.H. Issa, M.R. (1975) T
Chutjian, A. Thomas, L.D (1975) T
Flannery, M.R. et al. (1975) T
Flannery, M.R. et al (1975) T
Felden, Madeleine M. (1976) T
Scott, T. (1976) T
Scott, T. (1976) T
Scott, T. (1976) T


He { 1s² ¹S --> 1s4p ¹P }
×10⁻¹⁸
2.0
1.5
1.0
0.5
Cross section (cm²)
10¹
10²
10³
10⁴
10⁵
Electron energy (eV)
St.John, R.M. et al. (1964) E
Moustafa M., H.R. et al. (1969) E
Van Eck, J. et al. (1970) E
de Jongh, J.P. et al. (1972) E
Donaldson, F.G. et al. (1972) E
Showalter, J.G. Kay, R.B. (1975) E
Shemansky, D.E. et al. (1985) E
Bell, K.L. et al. (1969) T
Coleman, J.P. (1970) T
Baye, D. Heenen, P.-H. (1974) T
Narain, U. Chandra, S. (1974) T
Scott, T. (1976) T
Cartwright, D.C. et al. (1990) T
Fon, W.C. et al. (1991) T

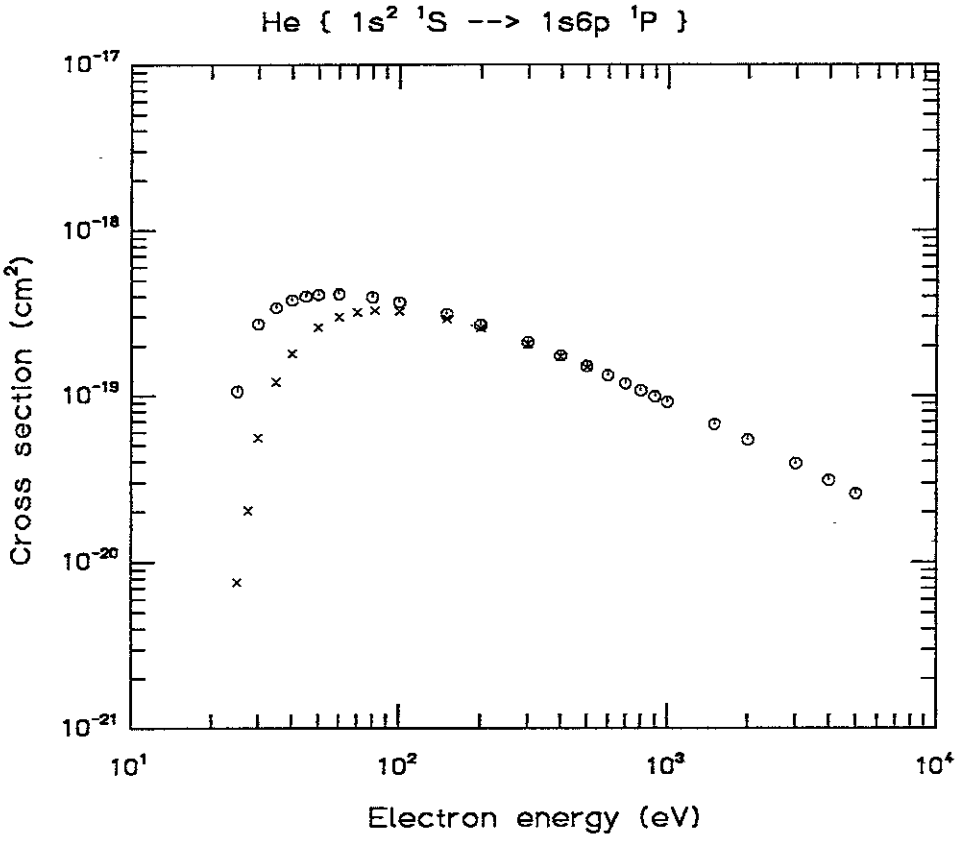

He { 1s² ¹S --> 1s4p ¹P }
10⁻¹⁷
10⁻¹⁸
10⁻¹⁹
10⁻²⁰
Cross section (cm²)
10¹
10²
10³
10⁴
10⁵
Electron energy (eV)
St.John, R.M. et al. (1964) E
Moustafa M., H.R. et al. (1969) E
Van Eck, J. et al. (1970) E
de Jongh, J.P. et al. (1972) E
Donaldson, F.G. et al. (1972) E
Showalter, J.G. Kay, R.B. (1975) E
Shemansky, D.E. et al. (1985) E
Bell, K.L. et al. (1969) T
Coleman, J.P. (1970) T
Baye, D. Heenen, P.-H. (1974) T
Narain, U. Chandra, S. (1974) T
Scott, T. (1976) T
Cartwright, D.C. et al. (1990) T
Fon, W.C. et al. (1991) T


He { 1s² ¹S --> 1s5p ¹P }
×10⁻¹⁹
8.0
6.0
4.0
2.0
Cross section (cm²)
10¹
10²
10³
10⁴
10⁵
Electron energy (eV)
Moustafa M., H.R. et al. (1969) E
Showalter, J.G. Kay, R.B. (1975) E
Bell, K.L. et al. (1969) T
Coleman, J.P. (1970) T
Baye, D. Heenen, P.-H. (1974) T
Narain, U. Chandra, S. (1974) T
Scott, T. (1976) T
Cartwright, D.C. et al. (1990) T

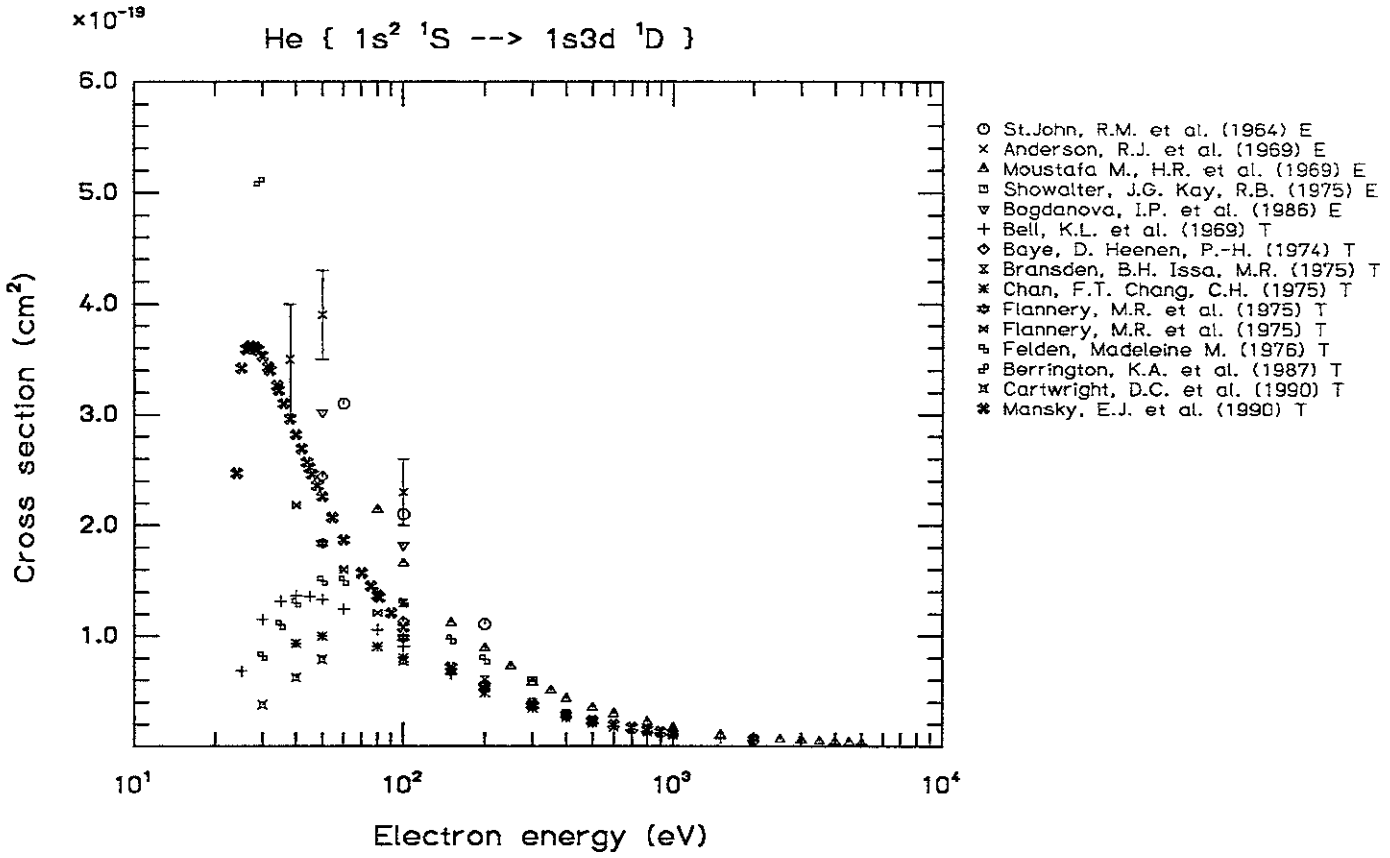

He { 1s² ¹S --> 1s5p ¹P }
10⁻¹⁸
10⁻¹⁹
10⁻²⁰
Cross section (cm²)
10¹
10²
10³
10⁴
10⁵
Electron energy (eV)
Moustafa M., H.R. et al. (1969) E
Showalter, J.G. Kay, R.B. (1975) E
Bell, K.L. et al. (1969) T
Coleman, J.P. (1970) T
Baye, D. Heenen, P.-H. (1974) T
Narain, U. Chandra, S. (1974) T
Scott, T. (1976) T
Cartwright, D.C. et al. (1990) T

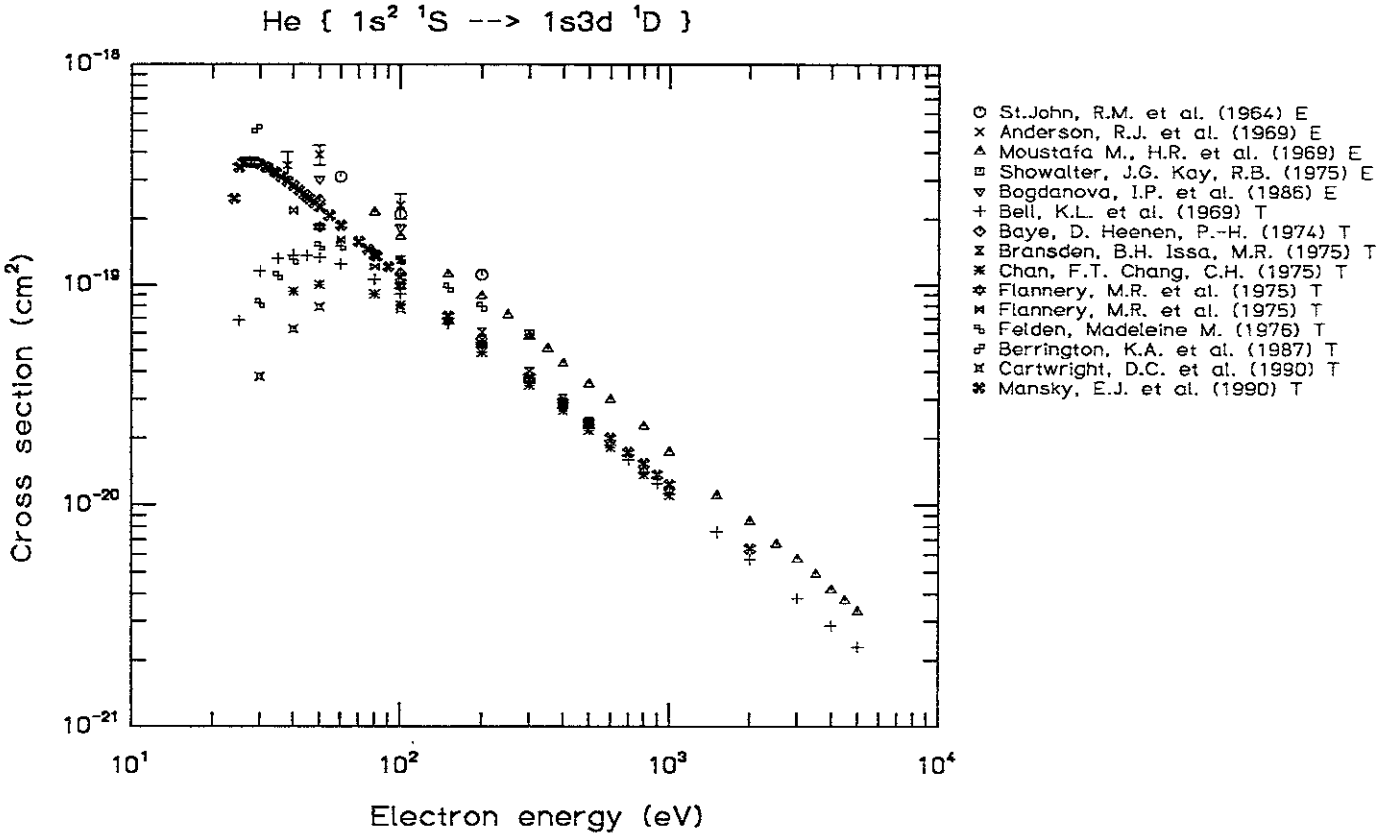


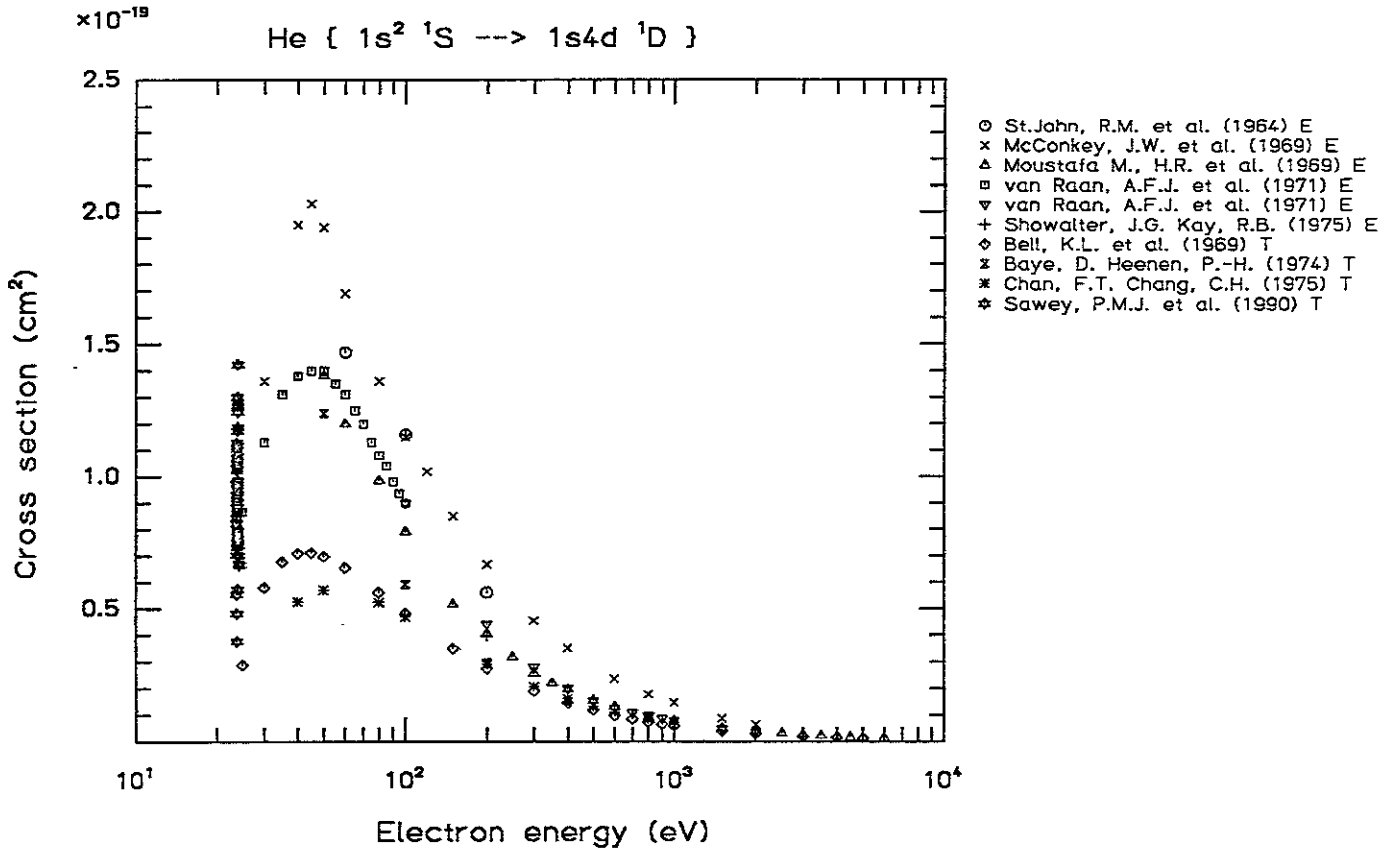

⊙ Bell, K.L. et al. (1969) T
× Cartwright, D.C. et al. (1990)

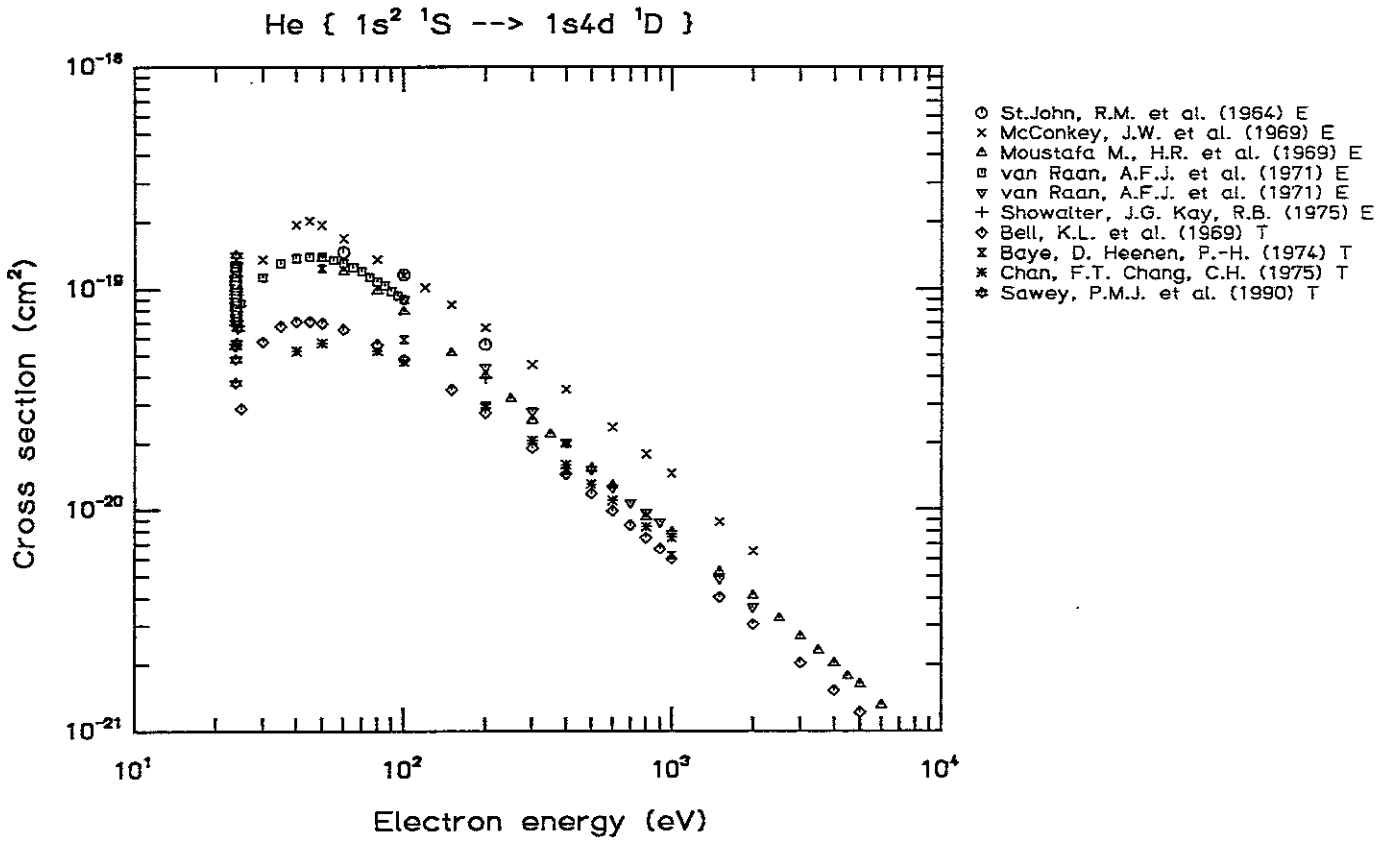


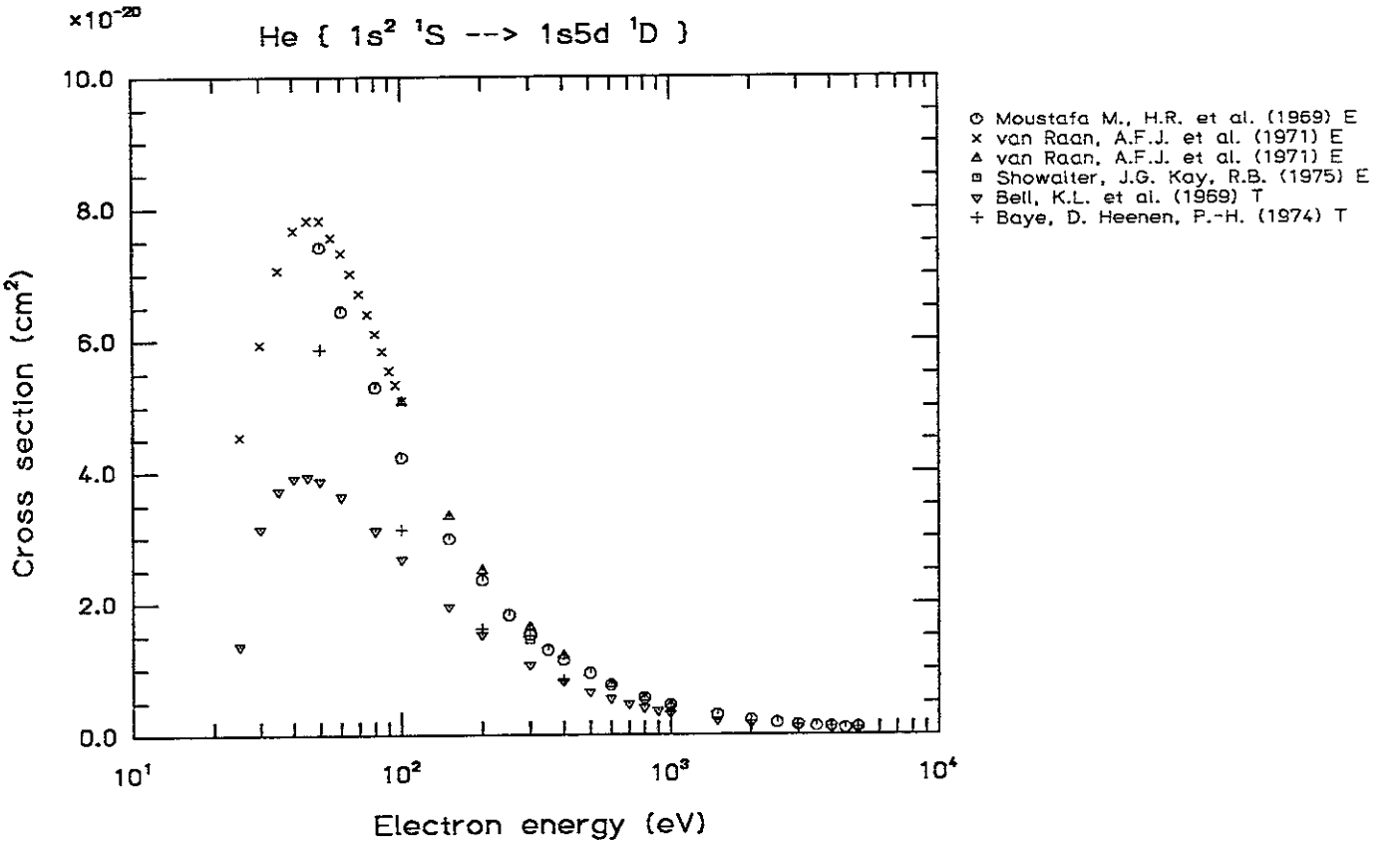

⊙ Bell, K.L. et al. (1969) T
× Cartwright, D.C. et al. (1990)

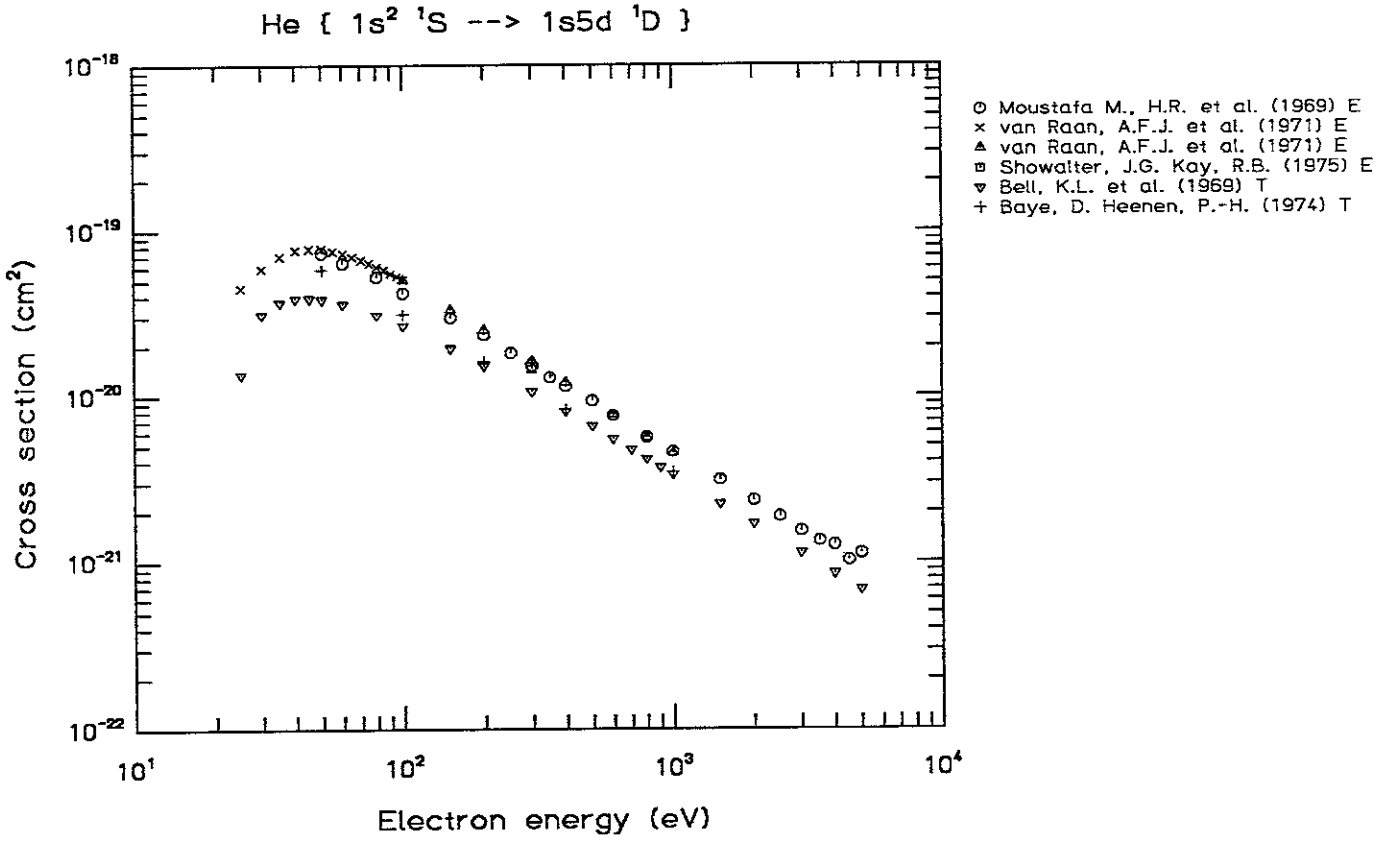

He { 1s² ¹S --> 1s3d ¹D }
×10⁻¹⁹
6.0
5.0
4.0
3.0
2.0
1.0
Cross section (cm²)
10¹
10²
10³
10⁴
Electron energy (eV)
St.John, R.M. et al. (1964) E
Anderson, R.J. et al. (1969) E
Moustafa M., H.R. et al. (1969) E
Showalter, J.G. Kay, R.B. (1975) E
Bogdanova, I.P. et al. (1986) E
Bell, K.L. et al. (1969) T
Baye, D. Heenen, P.-H. (1974) T
Bransden, B.H. Issa, M.R. (1975) T
Chan, F.T. Chang, C.H. (1975) T
Flannery, M.R. et al. (1975) T
Flannery, M.R. et al. (1975) T
Felden, Madeleine M. (1976) T
Berrington, K.A. et al. (1987) T
Cartwright, D.C. et al. (1990) T
Mansky, E.J. et al. (1990) T

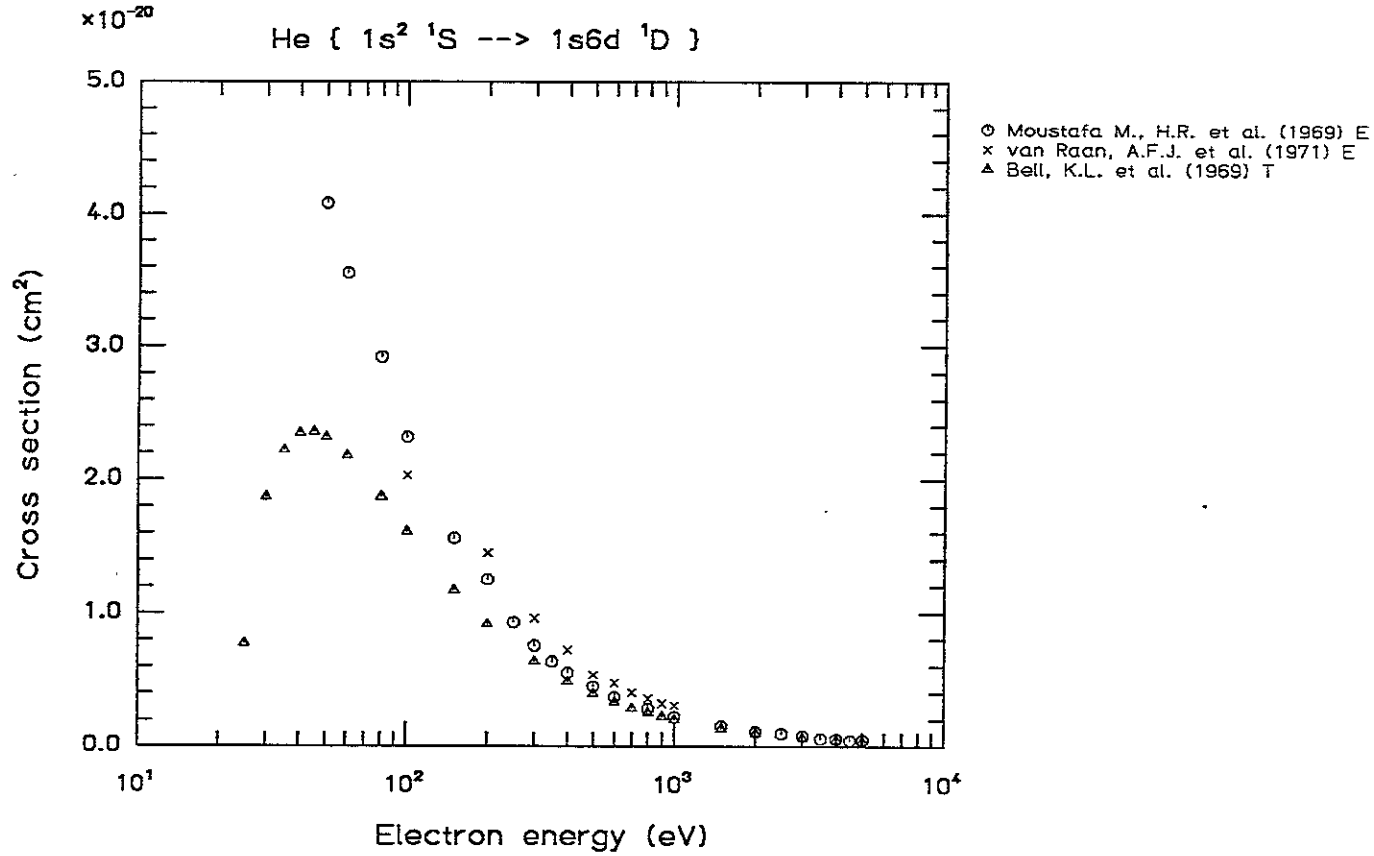

He { 1s² ¹S --> 1s3d ¹D }
10⁻¹⁸
10⁻¹⁹
10⁻²⁰
10⁻²¹
Cross section (cm²)
10¹
10²
10³
10⁴
Electron energy (eV)
St.John, R.M. et al. (1964) E
Anderson, R.J. et al. (1969) E
Moustafa M., H.R. et al. (1969) E
Showalter, J.G. Kay, R.B. (1975) E
Bogdanova, I.P. et al. (1986) E
Bell, K.L. et al. (1969) T
Baye, D. Heenen, P.-H. (1974) T
Bransden, B.H. Issa, M.R. (1975) T
Chan, F.T. Chang, C.H. (1975) T
Flannery, M.R. et al. (1975) T
Flannery, M.R. et al. (1975) T
Felden, Madeleine M. (1976) T
Berrington, K.A. et al. (1987) T
Cartwright, D.C. et al. (1990) T
Mansky, E.J. et al. (1990) T

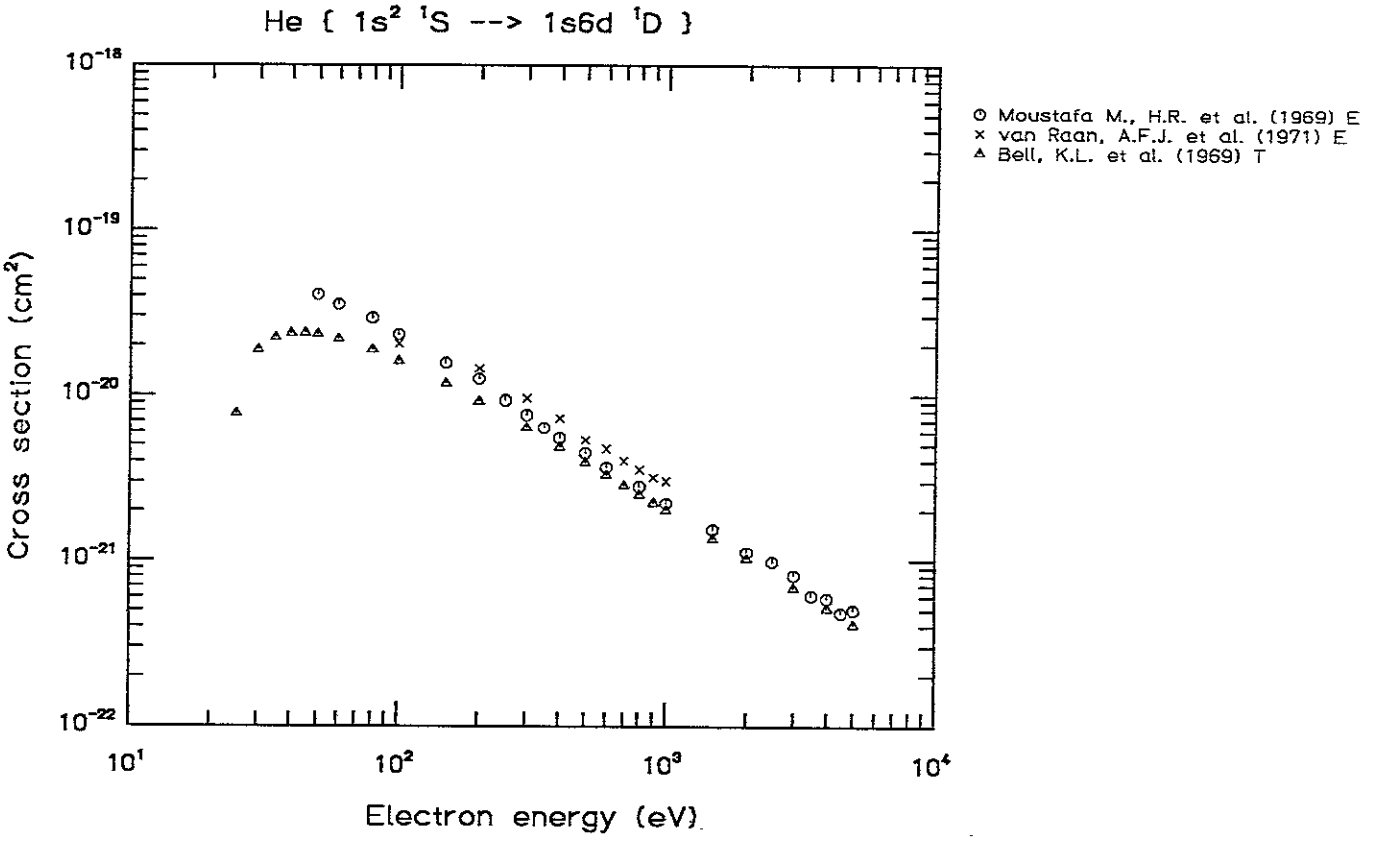

He { 1s² ¹S --> 1s4d ¹D }
×10⁻¹⁹
Cross section (cm²)
Electron energy (eV)
St.John, R.M. et al. (1964) E
McConkey, J.W. et al. (1969) E
Moustafa M., H.R. et al. (1969) E
van Raan, A.F.J. et al. (1971) E
van Raan, A.F.J. et al. (1971) E
Showalter, J.G. Kay, R.B. (1975) E
Bell, K.L. et al. (1969) T
Baye, D. Heenen, P.-H. (1974) T
Chan, F.T. Chang, C.H. (1975) T
Sawey, P.M.J. et al. (1990) T

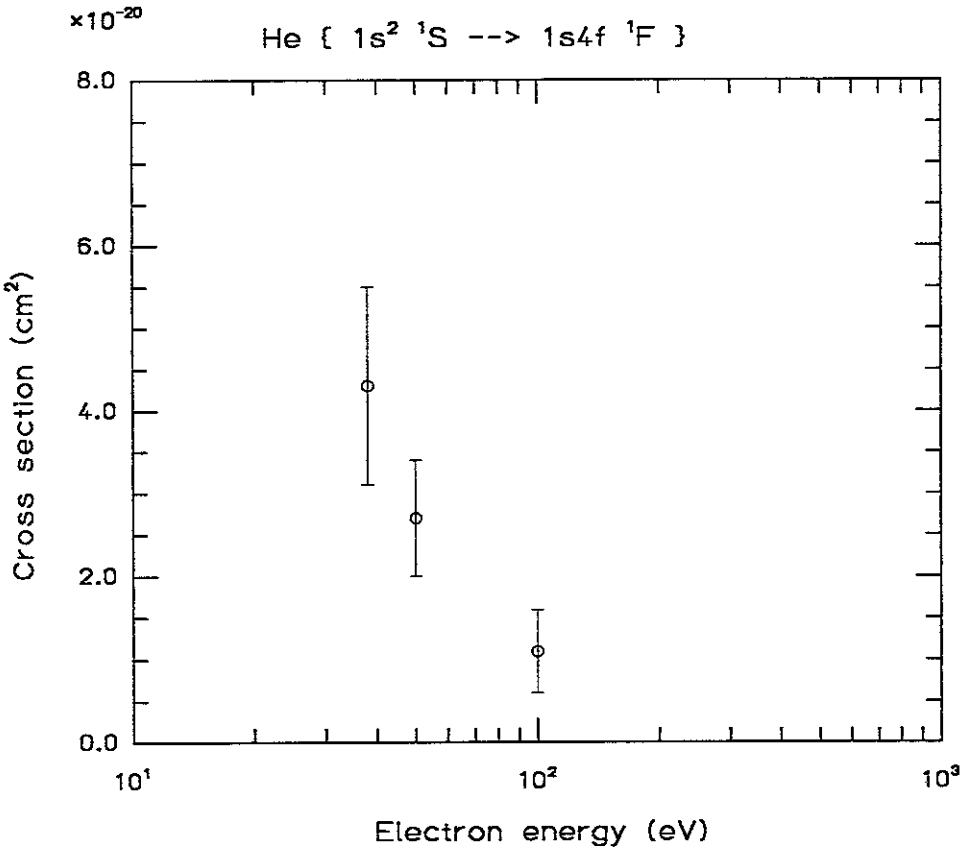

He { 1s² ¹S --> 1s4d ¹D }
Cross section (cm²)
Electron energy (eV)
St.John, R.M. et al. (1964) E
McConkey, J.W. et al. (1969) E
Moustafa M., H.R. et al. (1969) E
van Raan, A.F.J. et al. (1971) E
van Raan, A.F.J. et al. (1971) E
Showalter, J.G. Kay, R.B. (1975) E
Bell, K.L. et al. (1969) T
Baye, D. Heenen, P.-H. (1974) T
Chan, F.T. Chang, C.H. (1975) T
Sawey, P.M.J. et al. (1990) T


He { 1s² ¹S --> 1s5d ¹D }
×10⁻²⁰
10.0
8.0
6.0
4.0
2.0
0.0
Cross section (cm²)
10¹
10²
10³
10⁴
Electron energy (eV)
⊙ Moustafa M., H.R. et al. (1969) E
× van Raan, A.F.J. et al. (1971) E
▲ van Raan, A.F.J. et al. (1971) E
▫ Showalter, J.G. Kay, R.B. (1975) E
▽ Bell, K.L. et al. (1969) T
+ Baye, D. Heenen, P.-H. (1974) T

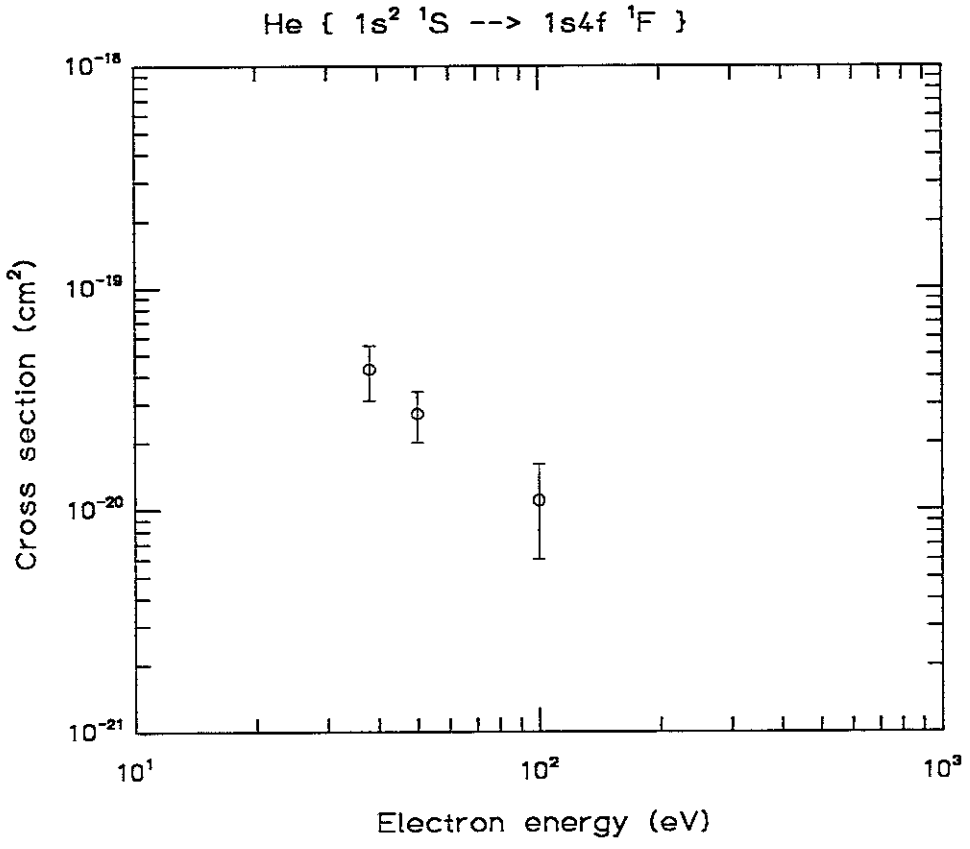

He { 1s² ¹S --> 1s5d ¹D }
10⁻¹⁸
10⁻¹⁹
10⁻²⁰
10⁻²¹
10⁻²²
Cross section (cm²)
10¹
10²
10³
10⁴
Electron energy (eV)
⊙ Moustafa M., H.R. et al. (1969) E
× van Raan, A.F.J. et al. (1971) E
▲ van Raan, A.F.J. et al. (1971) E
▫ Showalter, J.G. Kay, R.B. (1975) E
▽ Bell, K.L. et al. (1969) T
+ Baye, D. Heenen, P.-H. (1974) T

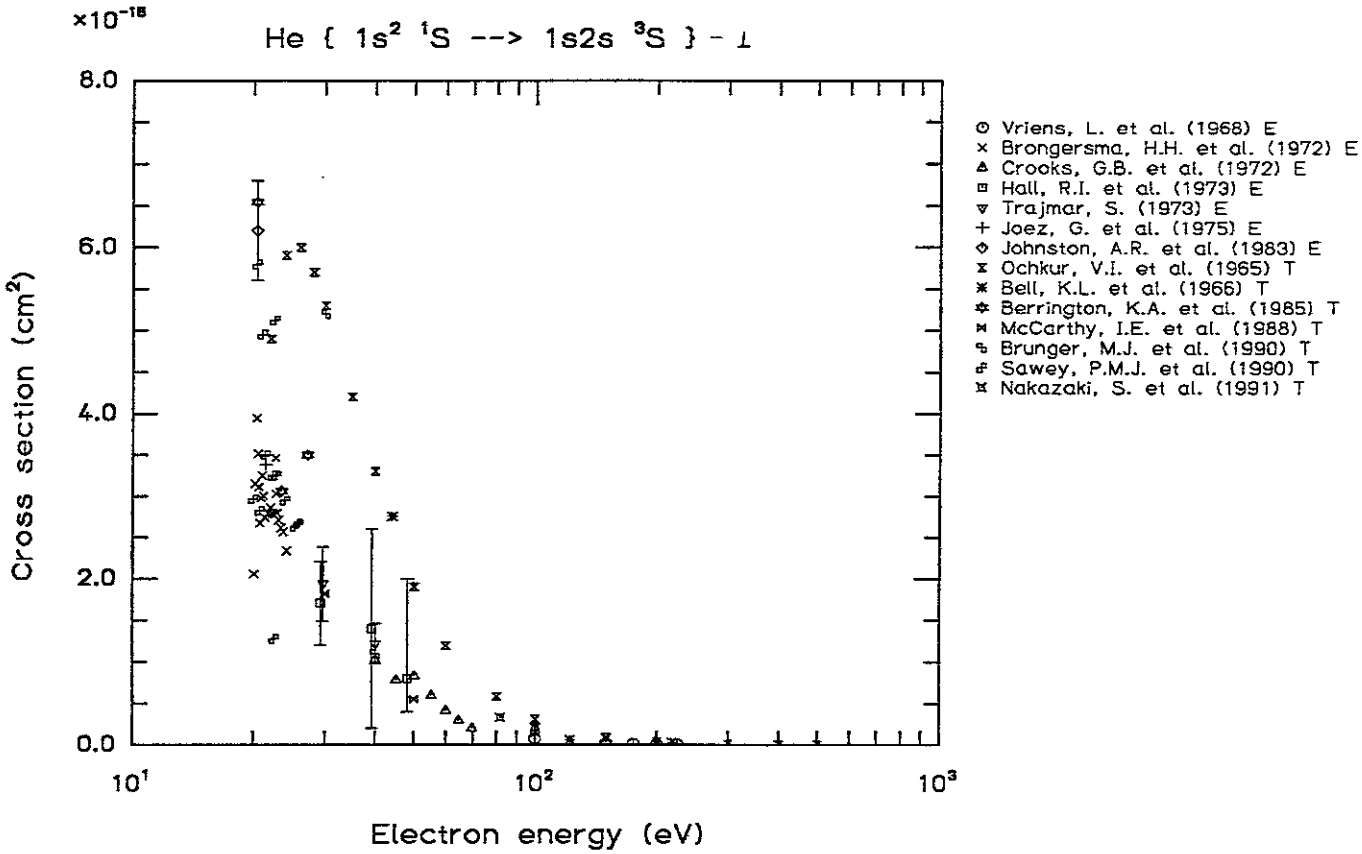

He { 1s² ¹S --> 1s6d ¹D }
×10⁻²⁰
5.0
4.0
3.0
2.0
1.0
0.0
Cross section (cm²)
10¹
10²
10³
10⁴
Electron energy (eV)
Moustafa M., H.R. et al. (1969) E
van Raan, A.F.J. et al. (1971) E
Bell, K.L. et al. (1969) T

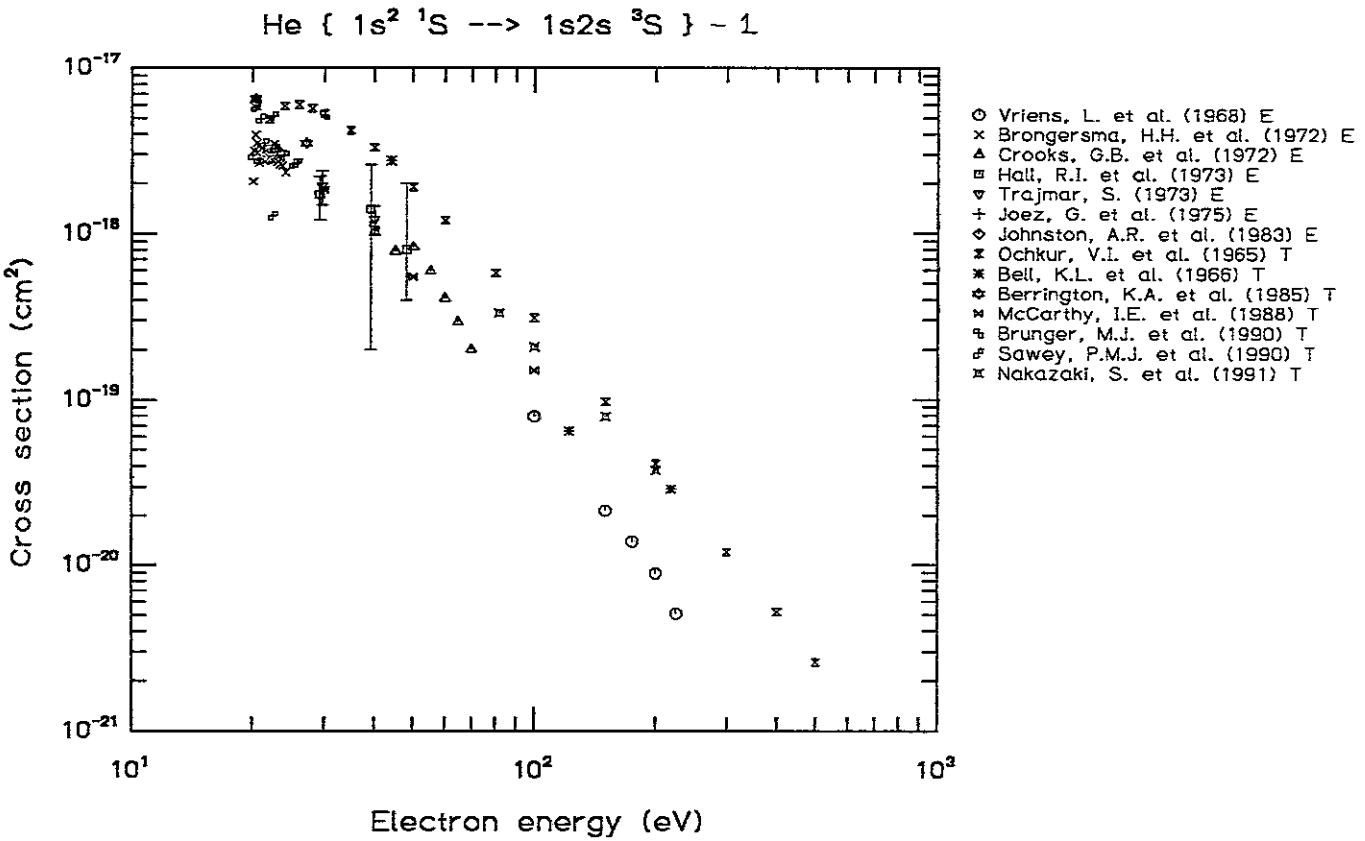

He { 1s² ¹S --> 1s6d ¹D }
10⁻¹⁸
10⁻¹⁹
10⁻²⁰
10⁻²¹
10⁻²²
Cross section (cm²)
10¹
10²
10³
10⁴
Electron energy (eV)
Moustafa M., H.R. et al. (1969) E
van Raan, A.F.J. et al. (1971) E
Bell, K.L. et al. (1969) T

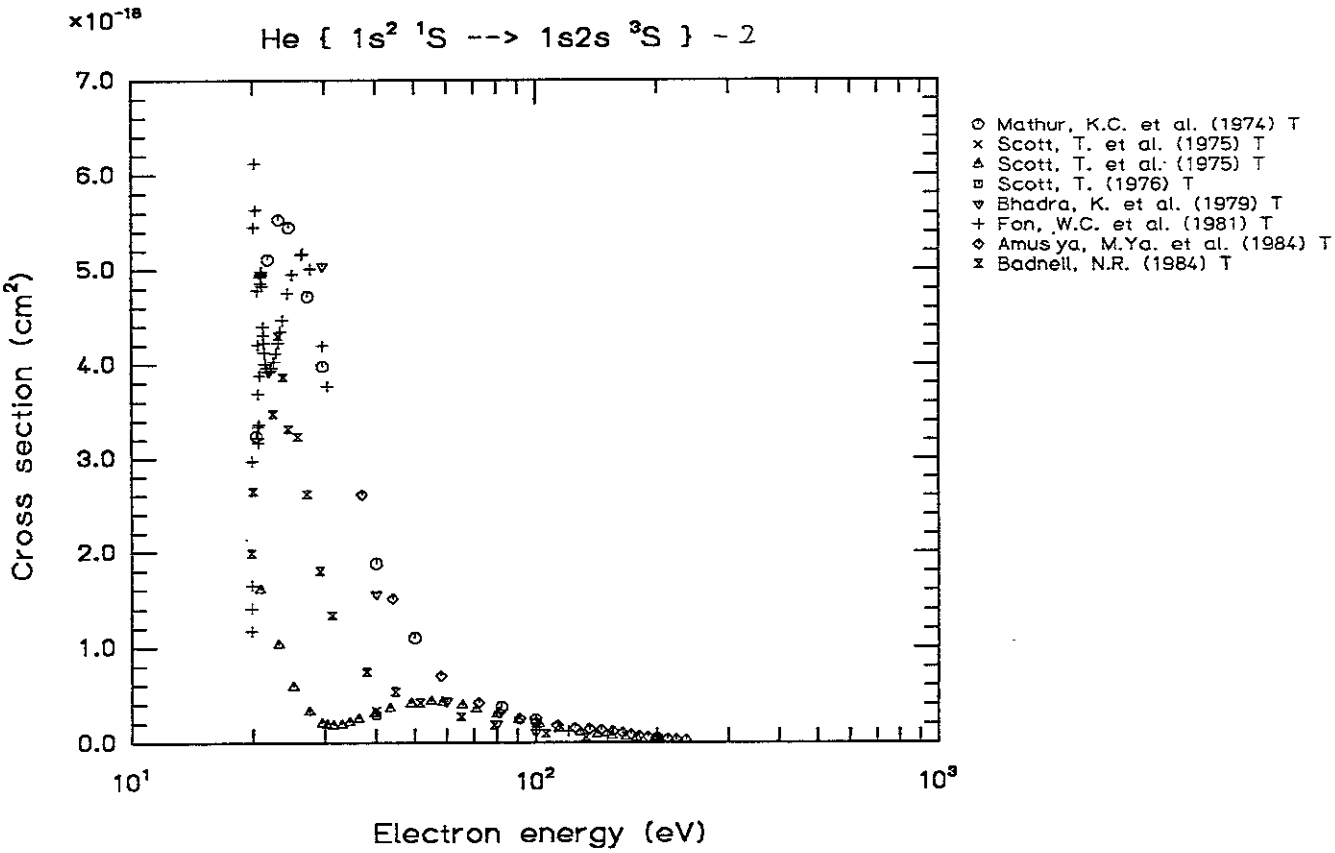


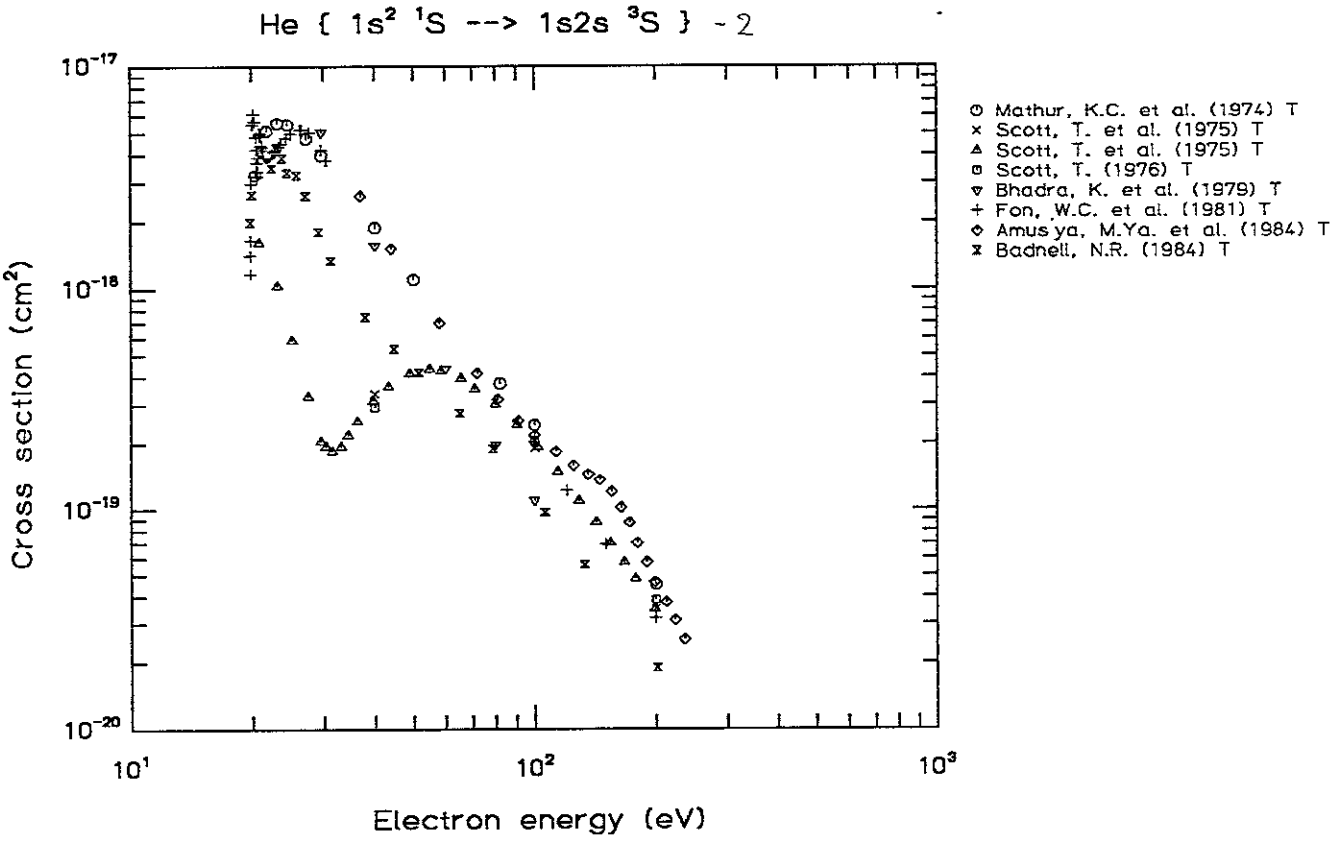


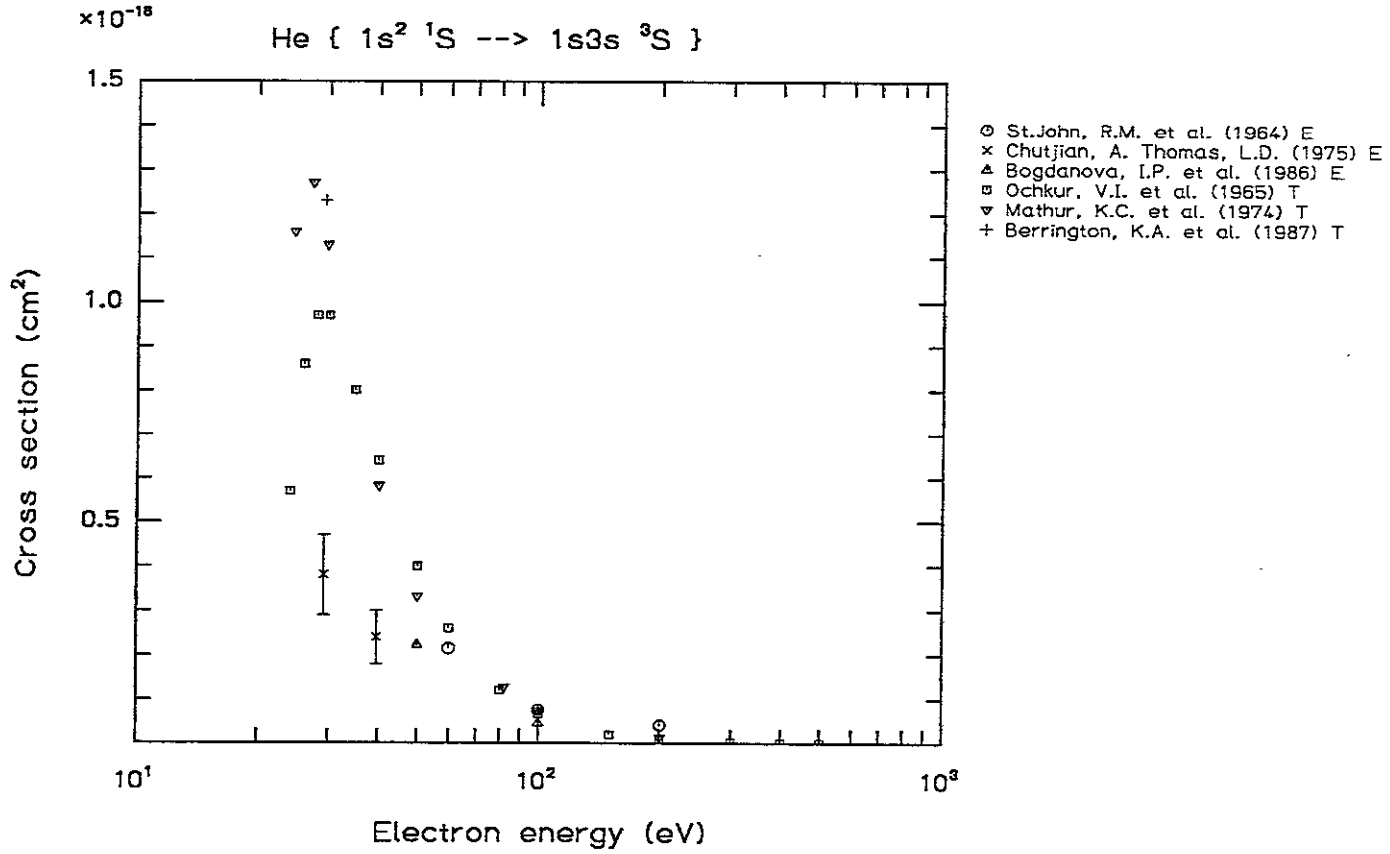



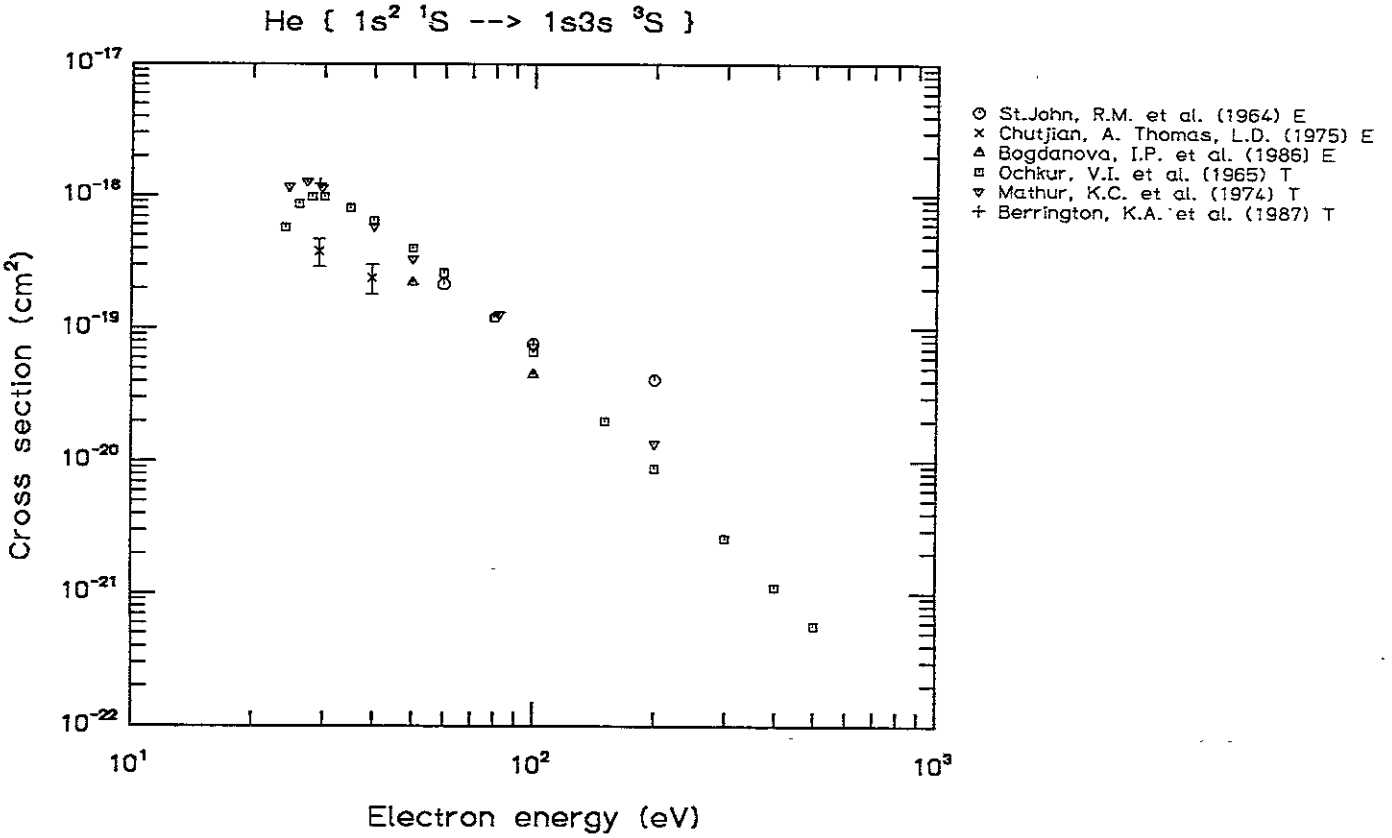

×10⁻¹⁵
He { 1s² ¹S --> 1s2s ³S } - 1
8.0
6.0
4.0
2.0
0.0
Cross section (cm²)
10¹
10²
10³
Electron energy (eV)
Vriens, L. et al. (1968) E
Brongersma, H.H. et al. (1972) E
Crooks, G.B. et al. (1972) E
Hall, R.I. et al. (1973) E
Trajmar, S. (1973) E
Joez, G. et al. (1975) E
Johnston, A.R. et al. (1983) E
Ochkur, V.I. et al. (1965) T
Bell, K.L. et al. (1966) T
Berrington, K.A. et al. (1985) T
McCarthy, I.E. et al. (1988) T
Brunger, M.J. et al. (1990) T
Sawey, P.M.J. et al. (1990) T
Nakazaki, S. et al. (1991) T

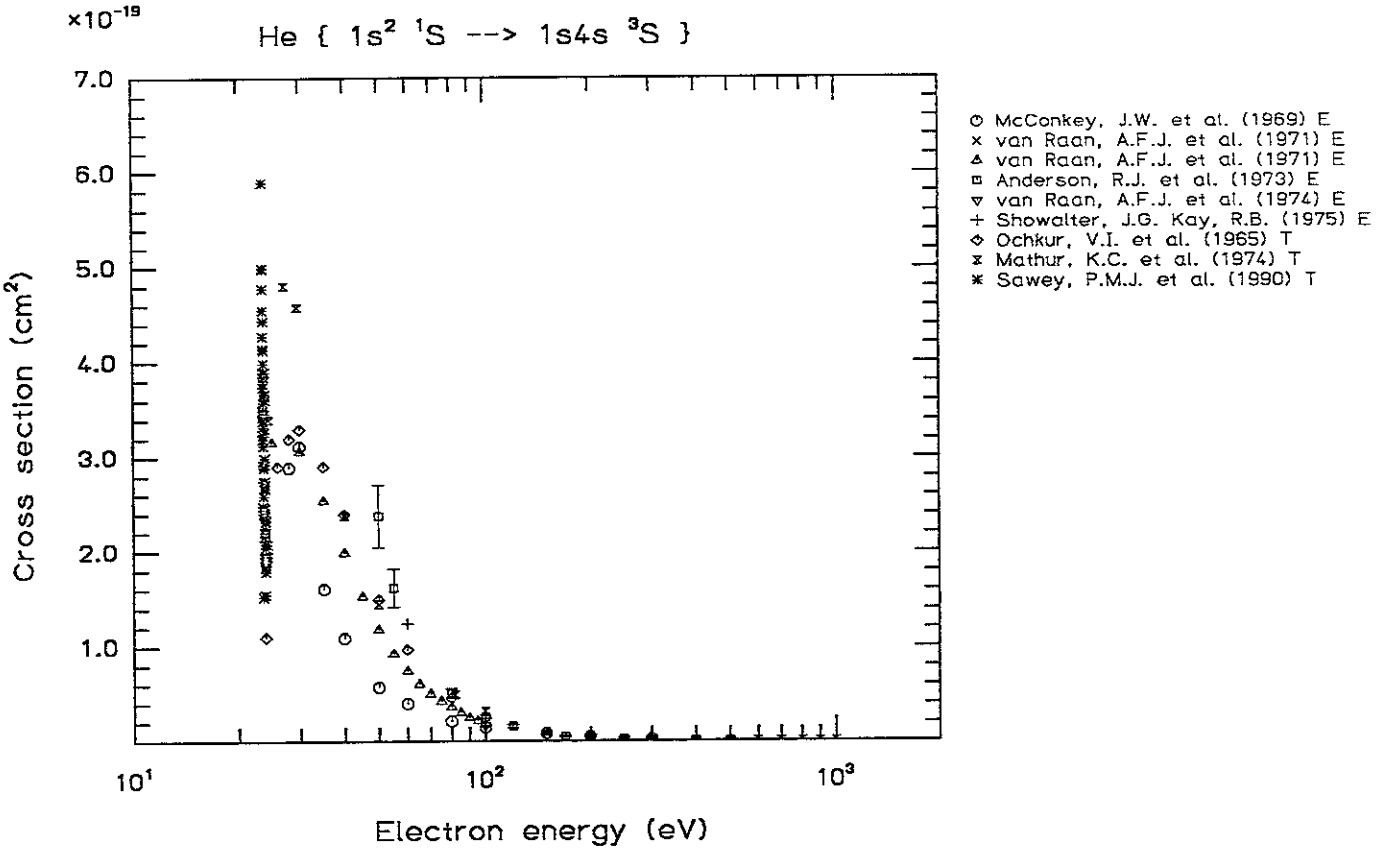

He { 1s² ¹S --> 1s2s ³S } - 1
10⁻¹⁷
10⁻¹⁸
10⁻¹⁹
10⁻²⁰
10⁻²¹
Cross section (cm²)
10¹
10²
10³
Electron energy (eV)
Vriens, L. et al. (1968) E
Brongersma, H.H. et al. (1972) E
Crooks, G.B. et al. (1972) E
Hall, R.I. et al. (1973) E
Trajmar, S. (1973) E
Joez, G. et al. (1975) E
Johnston, A.R. et al. (1983) E
Ochkur, V.I. et al. (1965) T
Bell, K.L. et al. (1966) T
Berrington, K.A. et al. (1985) T
McCarthy, I.E. et al. (1988) T
Brunger, M.J. et al. (1990) T
Sawey, P.M.J. et al. (1990) T
Nakazaki, S. et al. (1991) T

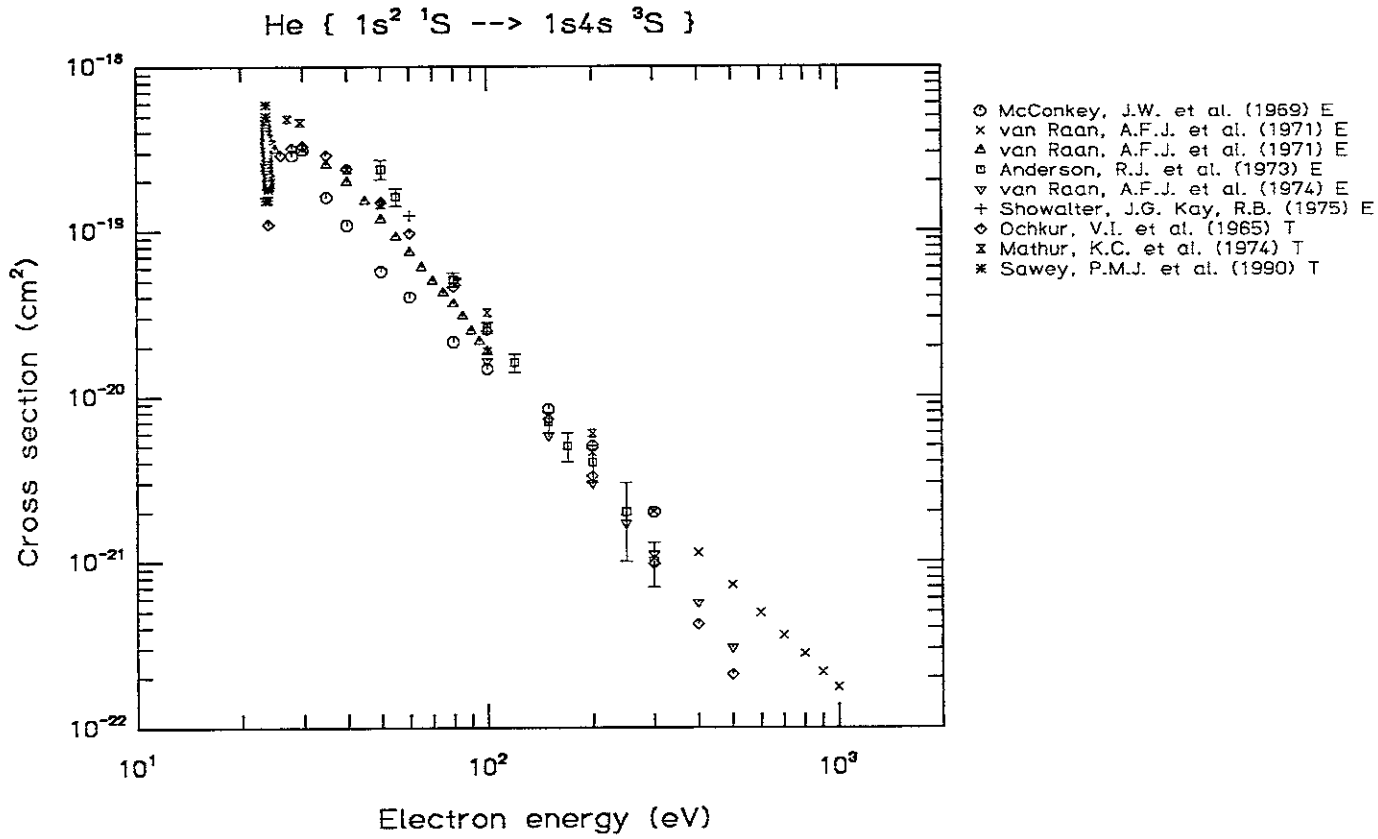

He { 1s² ¹S --> 1s2s ³S } - 2
×10⁻¹⁸
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Cross section (cm²)
10¹
10²
10³
Electron energy (eV)
Mathur, K.C. et al. (1974) T
Scott, T. et al. (1975) T
Scott, T. et al. (1975) T
Scott, T. (1976) T
Bhadra, K. et al. (1979) T
Fon, W.C. et al. (1981) T
Amus'ya, M.Ya. et al. (1984) T
Badnell, N.R. (1984) T

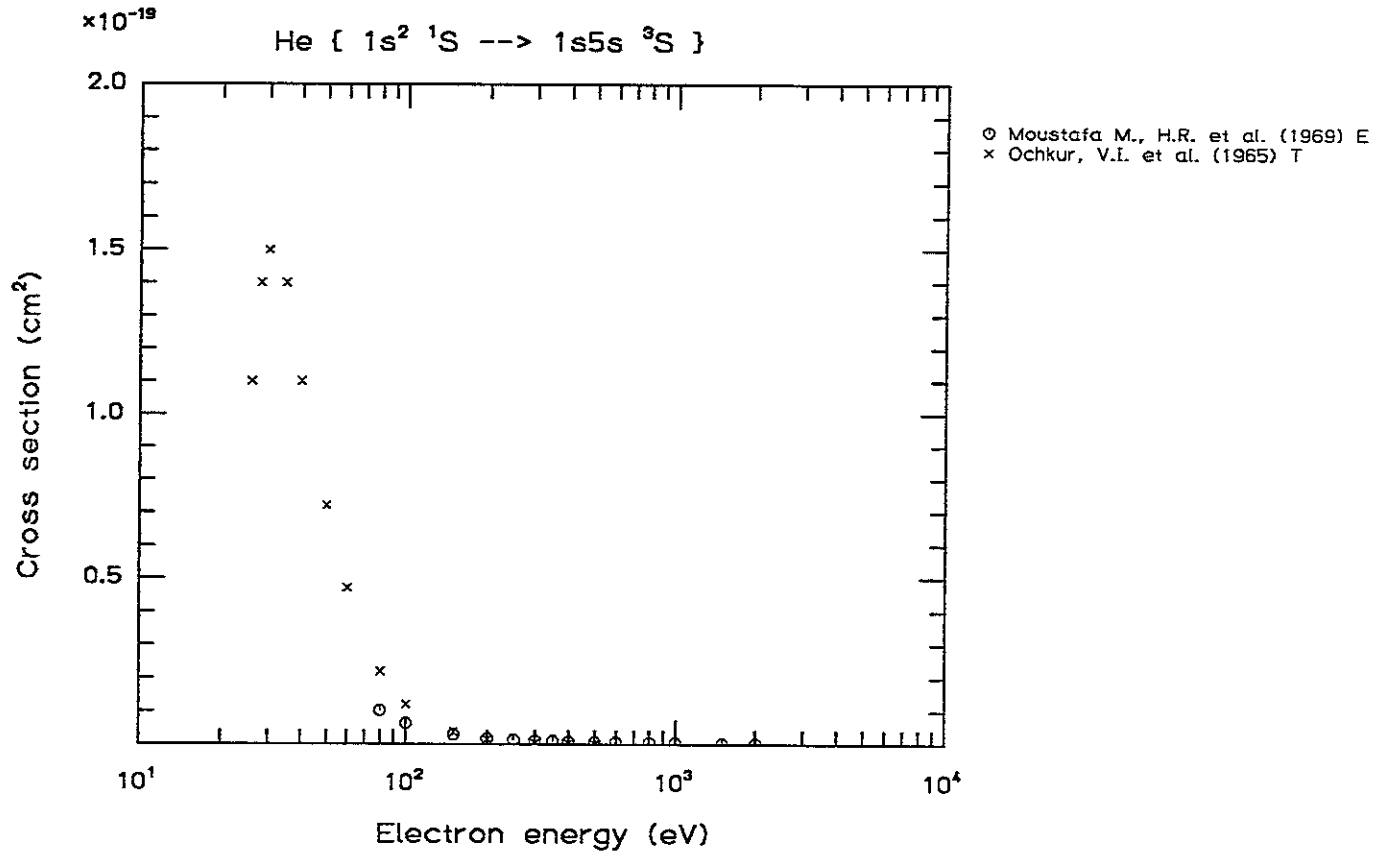

He { 1s² ¹S --> 1s2s ³S } - 2
10⁻¹⁷
10⁻¹⁸
10⁻¹⁹
10⁻²⁰
Cross section (cm²)
10¹
10²
10³
Electron energy (eV)
Mathur, K.C. et al. (1974) T
Scott, T. et al. (1975) T
Scott, T. et al. (1975) T
Scott, T. (1976) T
Bhadra, K. et al. (1979) T
Fon, W.C. et al. (1981) T
Amus'ya, M.Ya. et al. (1984) T
Badnell, N.R. (1984) T

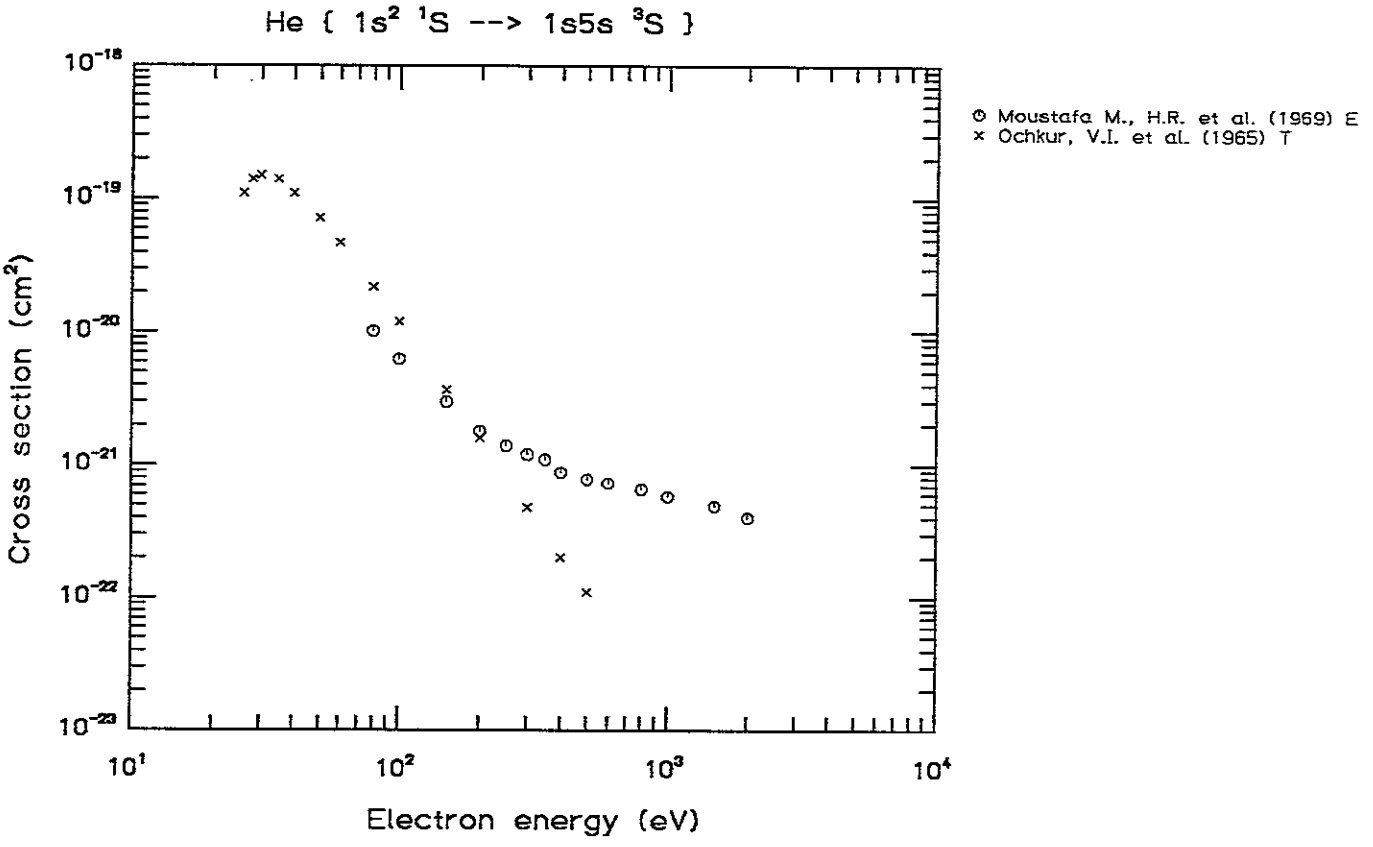

He { 1s² ¹S --> 1s3s ³S }
×10⁻¹⁸
1.5
1.0
0.5
Cross section (cm²)
10¹
10²
10³
Electron energy (eV)
St.John, R.M. et al. (1964) E
Chutjian, A. Thomas, L.D. (1975) E
Bogdanova, I.P. et al. (1986) E
Ochkur, V.I. et al. (1965) T
Mathur, K.C. et al. (1974) T
Berrington, K.A. et al. (1987) T

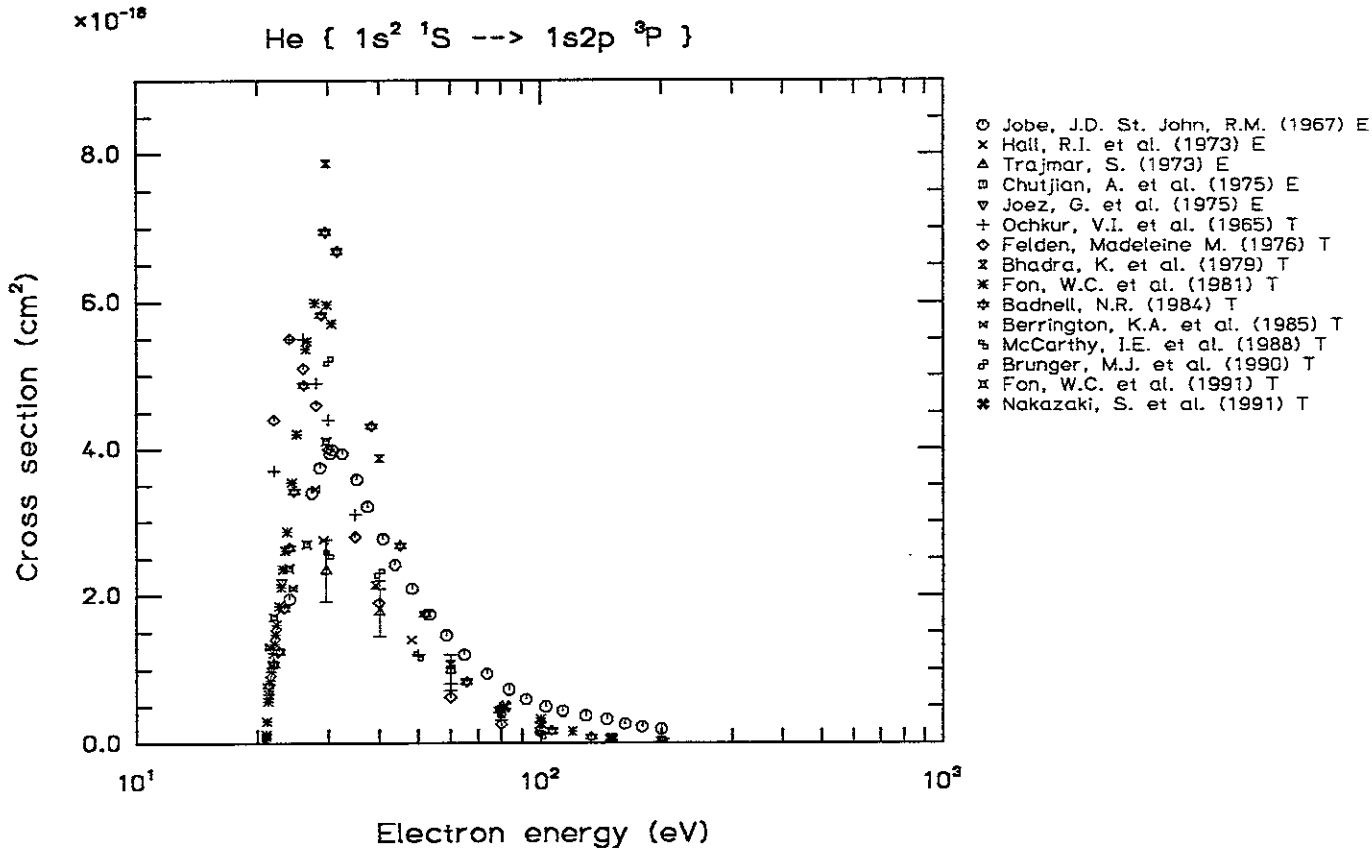

He { 1s² ¹S --> 1s3s ³S }
10⁻¹⁷
10⁻¹⁸
10⁻¹⁹
10⁻²⁰
10⁻²¹
10⁻²²
Cross section (cm²)
10¹
10²
10³
Electron energy (eV)
St.John, R.M. et al. (1964) E
Chutjian, A. Thomas, L.D. (1975) E
Bogdanova, I.P. et al. (1986) E
Ochkur, V.I. et al. (1965) T
Mathur, K.C. et al. (1974) T
Berrington, K.A. et al. (1987) T

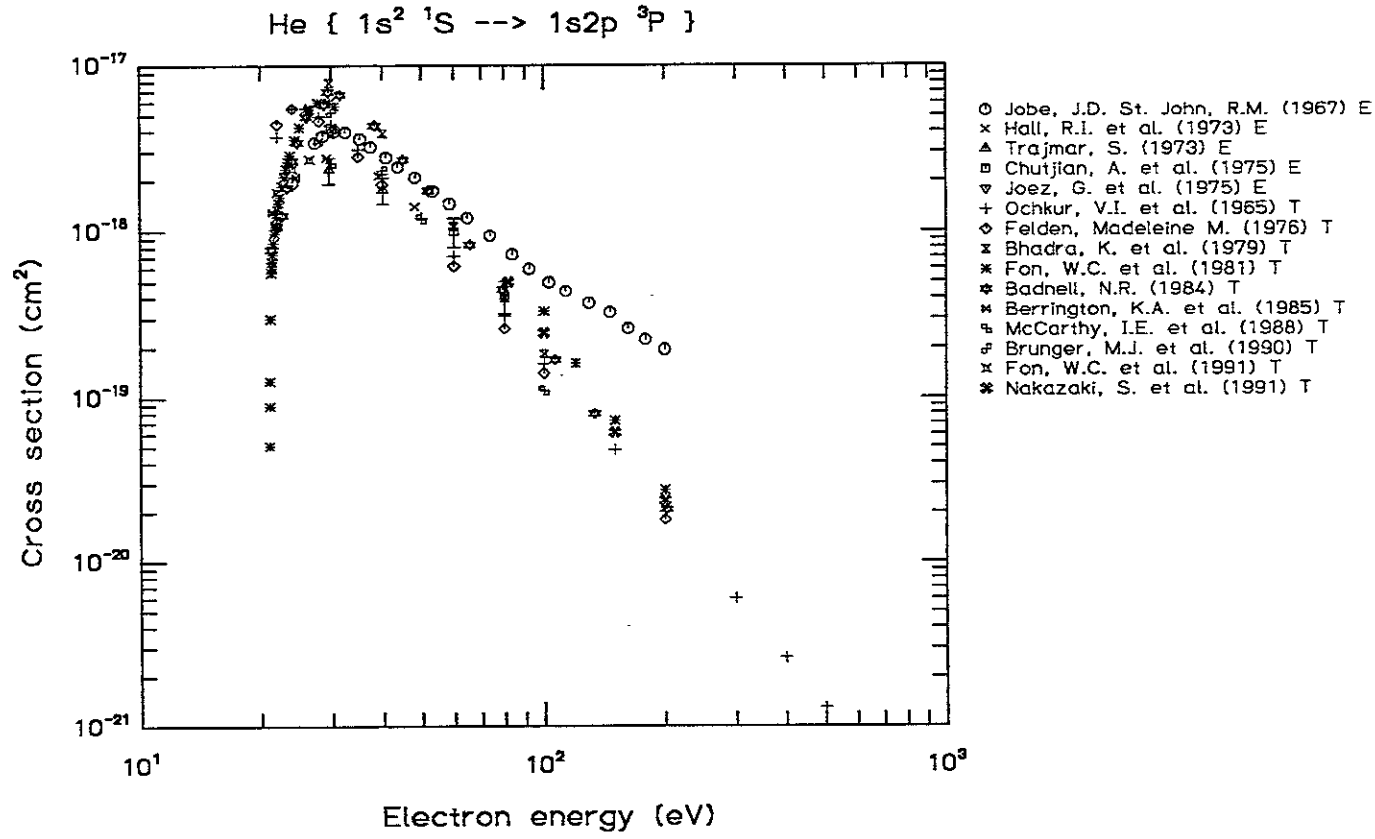

He { 1s² ¹S --> 1s4s ³S }
×10⁻¹⁹
7.0
6.0
5.0
4.0
3.0
2.0
1.0
Cross section (cm²)
10¹
10²
10³
Electron energy (eV)
McConkey, J.W. et al. (1969) E
van Raan, A.F.J. et al. (1971) E
van Raan, A.F.J. et al. (1971) E
Anderson, R.J. et al. (1973) E
van Raan, A.F.J. et al. (1974) E
Showalter, J.G. Kay, R.B. (1975) E
Ochkur, V.I. et al. (1965) T
Mathur, K.C. et al. (1974) T
Sawey, P.M.J. et al. (1990) T

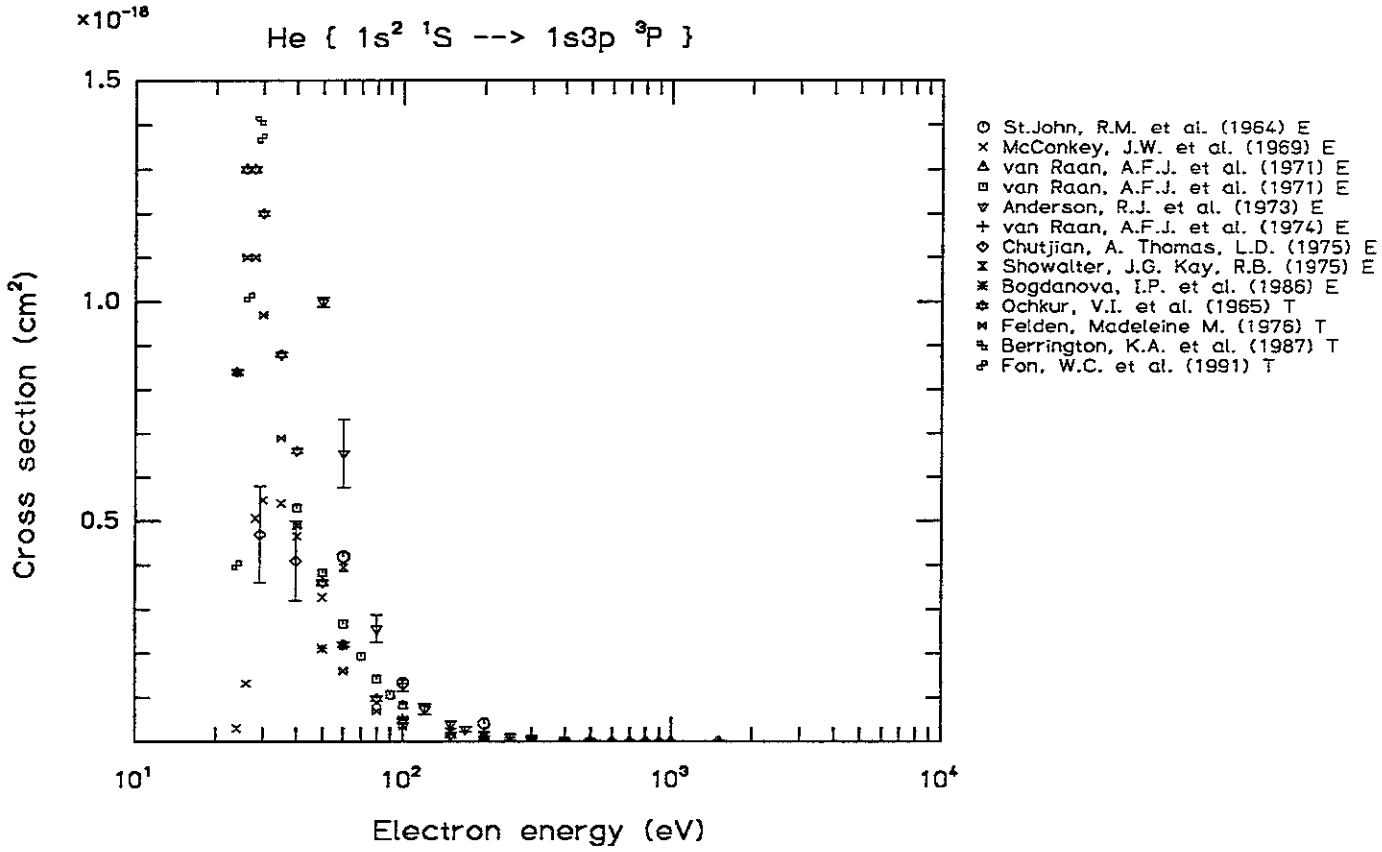

He { 1s² ¹S --> 1s4s ³S }
10⁻¹⁸
10⁻¹⁹
10⁻²⁰
10⁻²¹
10⁻²²
Cross section (cm²)
10¹
10²
10³
Electron energy (eV)
McConkey, J.W. et al. (1969) E
van Raan, A.F.J. et al. (1971) E
van Raan, A.F.J. et al. (1971) E
Anderson, R.J. et al. (1973) E
van Raan, A.F.J. et al. (1974) E
Showalter, J.G. Kay, R.B. (1975) E
Ochkur, V.I. et al. (1965) T
Mathur, K.C. et al. (1974) T
Sawey, P.M.J. et al. (1990) T

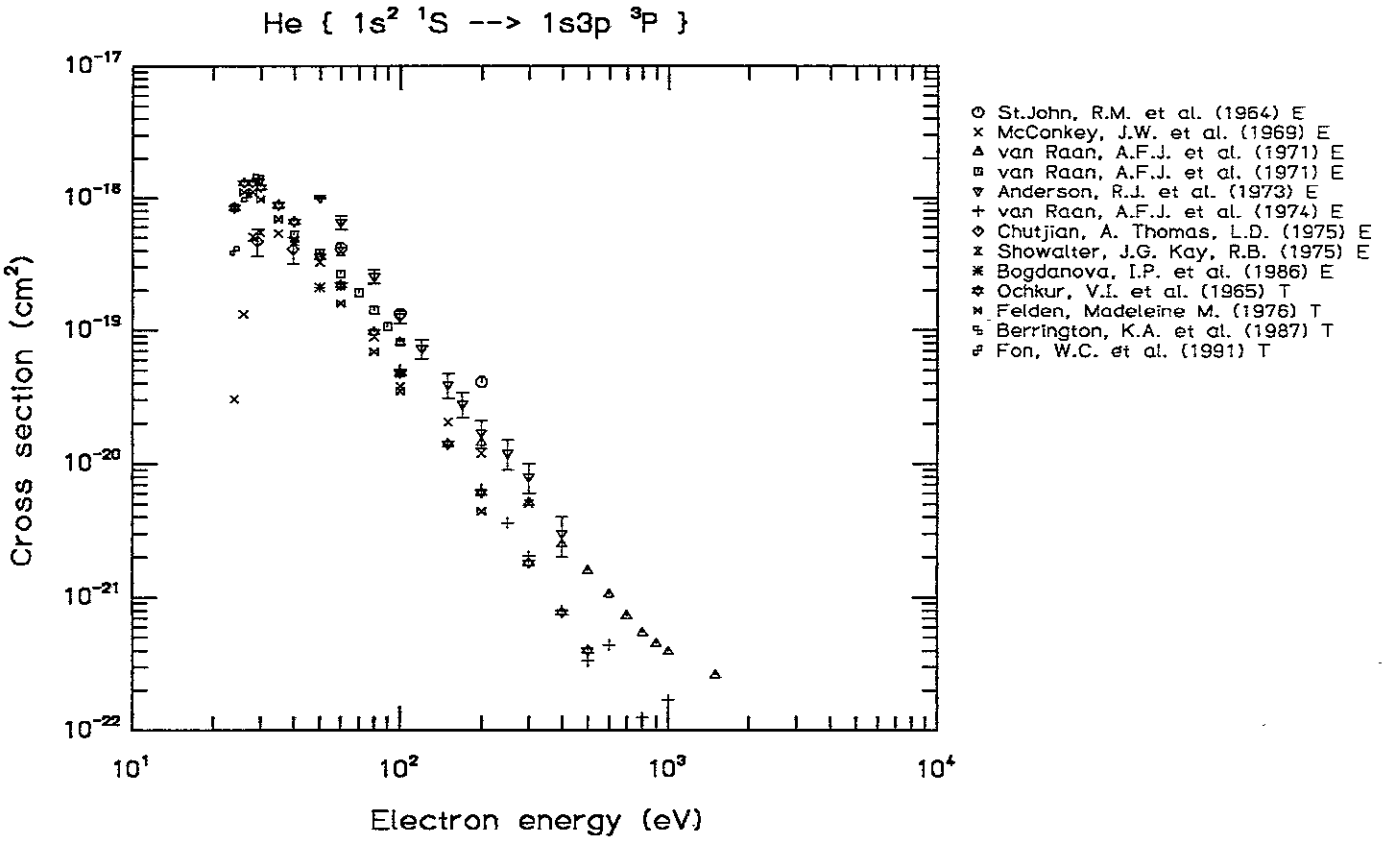

He { 1s² ¹S --> 1s5s ³S }
×10⁻¹⁹
2.0
1.5
1.0
0.5
Cross section (cm²)
10¹
10²
10³
10⁴
Electron energy (eV)
⊙ Moustafa M., H.R. et al. (1969) E
× Ochkur, V.I. et al. (1965) T

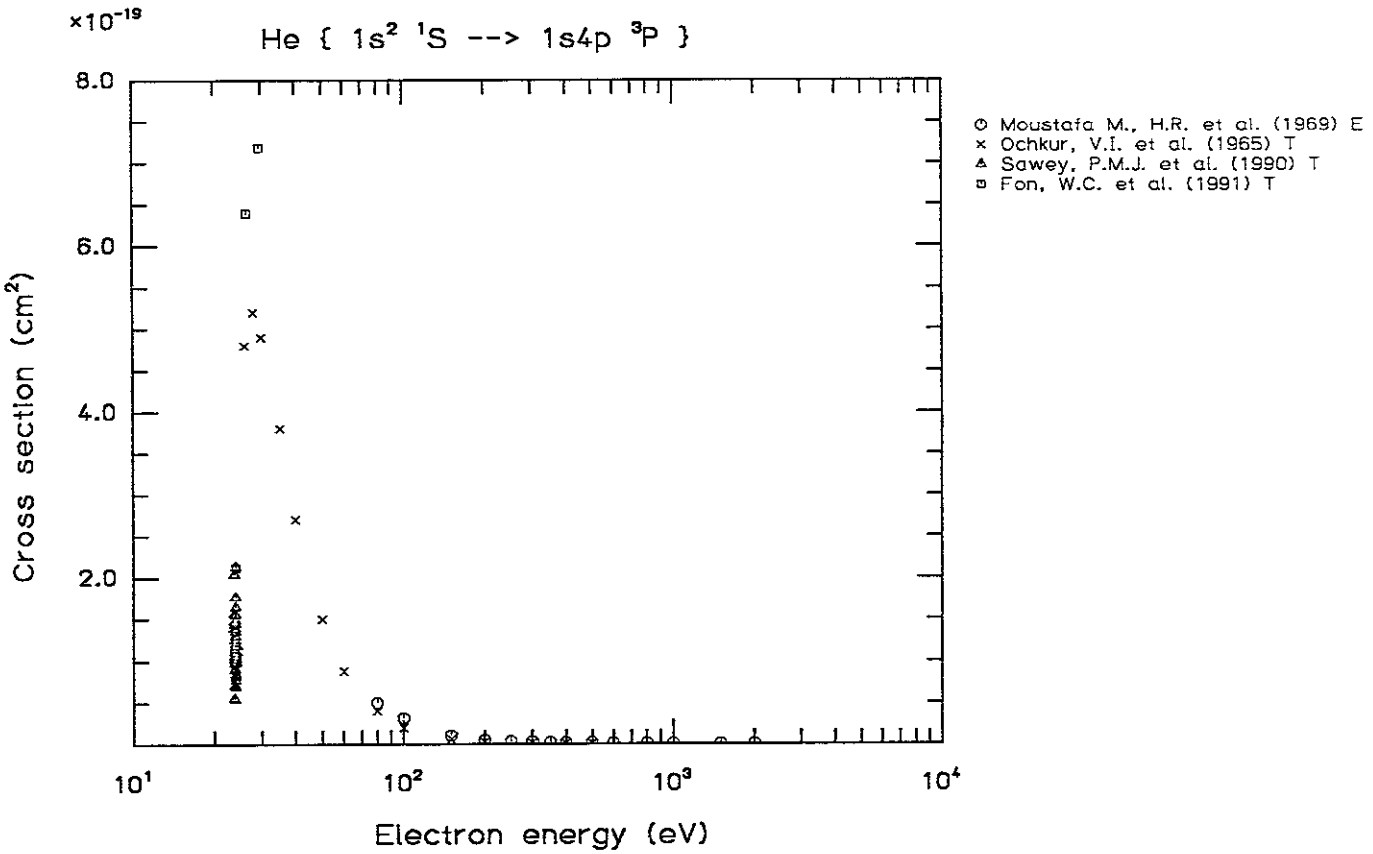

He { 1s² ¹S --> 1s5s ³S }
10⁻¹⁸
10⁻¹⁹
10⁻²⁰
10⁻²¹
10⁻²²
10⁻²³
Cross section (cm²)
10¹
10²
10³
10⁴
Electron energy (eV)
⊙ Moustafa M., H.R. et al. (1969) E
× Ochkur, V.I. et al. (1965) T

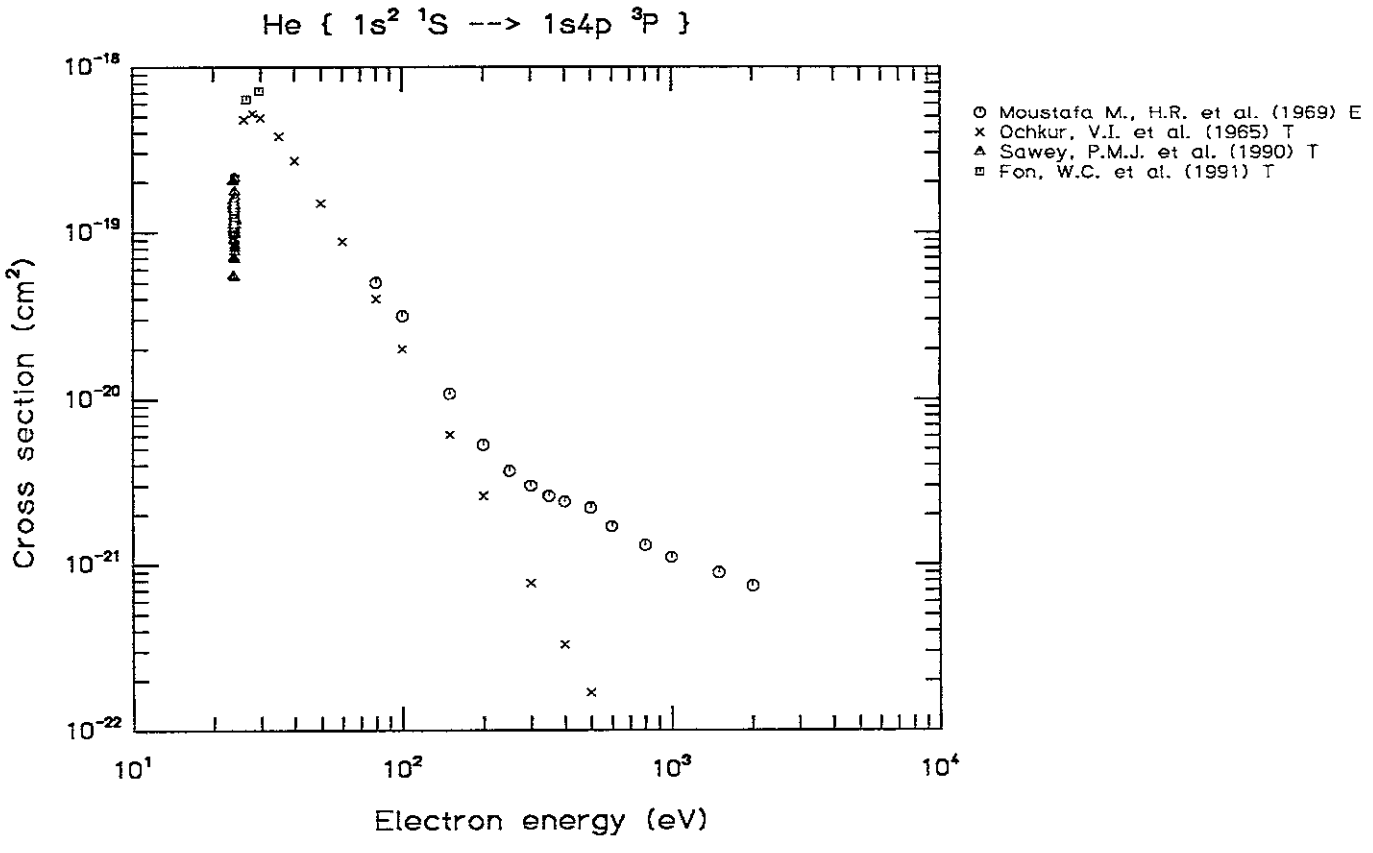

He { 1s² ¹S --> 1s2p ³P }
×10⁻¹⁸
Cross section (cm²)
8.0
6.0
4.0
2.0
0.0
10¹
10²
10³
Electron energy (eV)
Jobe, J.D. St. John, R.M. (1967) E
Hall, R.I. et al. (1973) E
Trajmar, S. (1973) E
Chutjian, A. et al. (1975) E
Joez, G. et al. (1975) E
Ochkur, V.I. et al. (1965) T
Felden, Madeleine M. (1976) T
Bhadra, K. et al. (1979) T
Fon, W.C. et al. (1981) T
Badnell, N.R. (1984) T
Berrington, K.A. et al. (1985) T
McCarthy, I.E. et al. (1988) T
Brunger, M.J. et al. (1990) T
Fon, W.C. et al. (1991) T
Nakazaki, S. et al. (1991) T


He { 1s² ¹S --> 1s2p ³P }
Cross section (cm²)
10⁻¹⁷
10⁻¹⁸
10⁻¹⁹
10⁻²⁰
10⁻²¹
10¹
10²
10³
Electron energy (eV)
Jobe, J.D. St. John, R.M. (1967) E
Hall, R.I. et al. (1973) E
Trajmar, S. (1973) E
Chutjian, A. et al. (1975) E
Joez, G. et al. (1975) E
Ochkur, V.I. et al. (1965) T
Felden, Madeleine M. (1976) T
Bhadra, K. et al. (1979) T
Fon, W.C. et al. (1981) T
Badnell, N.R. (1984) T
Berrington, K.A. et al. (1985) T
McCarthy, I.E. et al. (1988) T
Brunger, M.J. et al. (1990) T
Fon, W.C. et al. (1991) T
Nakazaki, S. et al. (1991) T


He { 1s² ¹S --> 1s3p ³P }
×10⁻¹⁸
1.5
1.0
0.5
Cross section (cm²)
10¹
10²
10³
10⁴
Electron energy (eV)
St.John, R.M. et al. (1964) E
McConkey, J.W. et al. (1969) E
van Raan, A.F.J. et al. (1971) E
van Raan, A.F.J. et al. (1971) E
Anderson, R.J. et al. (1973) E
van Raan, A.F.J. et al. (1974) E
Chutjian, A. Thomas, L.D. (1975) E
Showalter, J.G. Kay, R.B. (1975) E
Bogdanova, I.P. et al. (1986) E
Ochkur, V.I. et al. (1965) T
Felden, Madeleine M. (1976) T
Berrington, K.A. et al. (1987) T
Fon, W.C. et al. (1991) T


He { 1s² ¹S --> 1s3p ³P }
10⁻¹⁷
10⁻¹⁸
10⁻¹⁹
10⁻²⁰
10⁻²¹
10⁻²²
Cross section (cm²)
10¹
10²
10³
10⁴
Electron energy (eV)
St.John, R.M. et al. (1964) E
McConkey, J.W. et al. (1969) E
van Raan, A.F.J. et al. (1971) E
van Raan, A.F.J. et al. (1971) E
Anderson, R.J. et al. (1973) E
van Raan, A.F.J. et al. (1974) E
Chutjian, A. Thomas, L.D. (1975) E
Showalter, J.G. Kay, R.B. (1975) E
Bogdanova, I.P. et al. (1986) E
Ochkur, V.I. et al. (1965) T
Felden, Madeleine M. (1976) T
Berrington, K.A. et al. (1987) T
Fon, W.C. et al. (1991) T


He { 1s² ¹S --> 1s4p ³P }
×10⁻¹⁹
8.0
6.0
4.0
2.0
Cross section (cm²)
10¹
10²
10³
10⁴
Electron energy (eV)
Moustafa M., H.R. et al. (1969) E
Ochkur, V.I. et al. (1965) T
Sawey, P.M.J. et al. (1990) T
Fon, W.C. et al. (1991) T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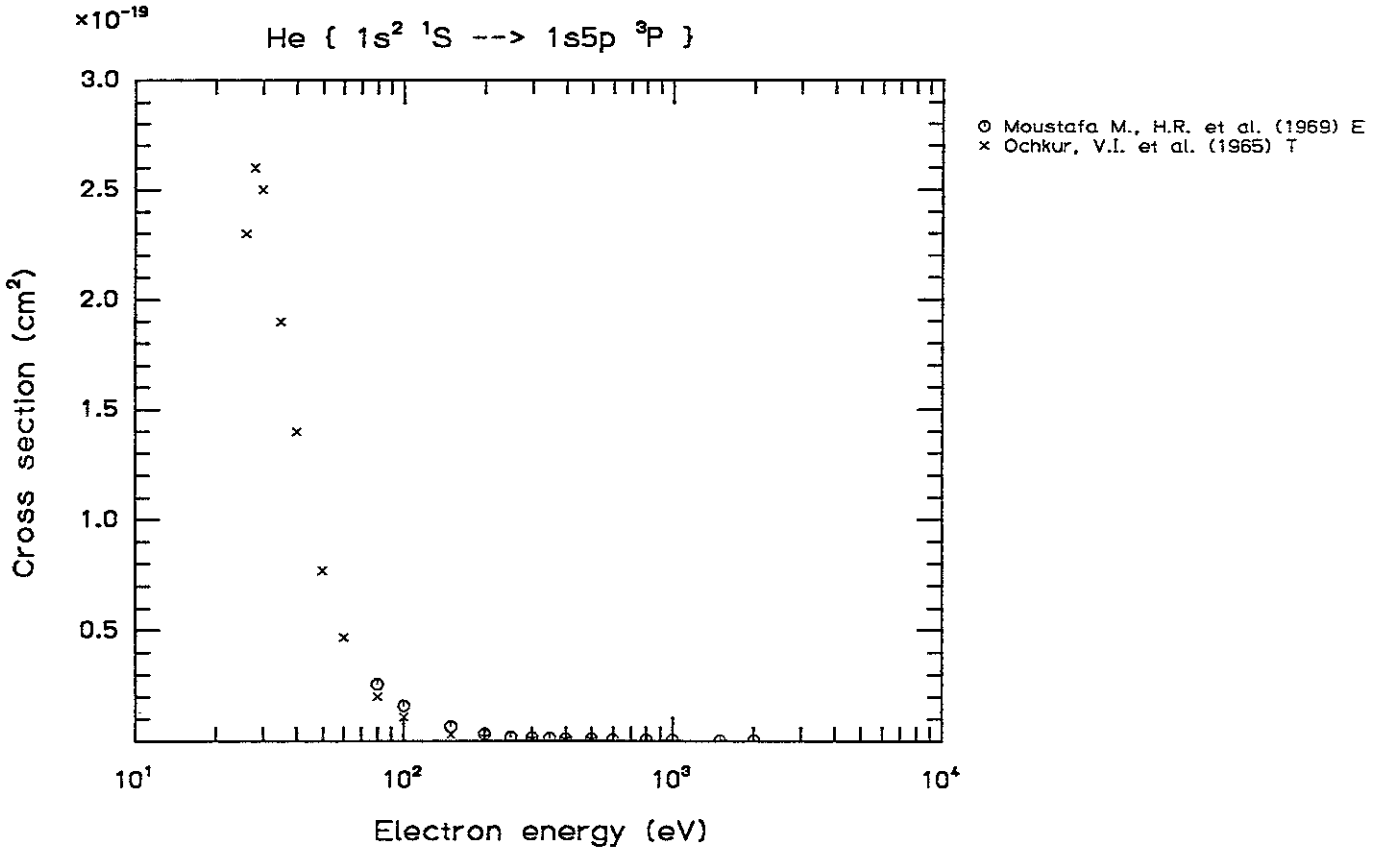
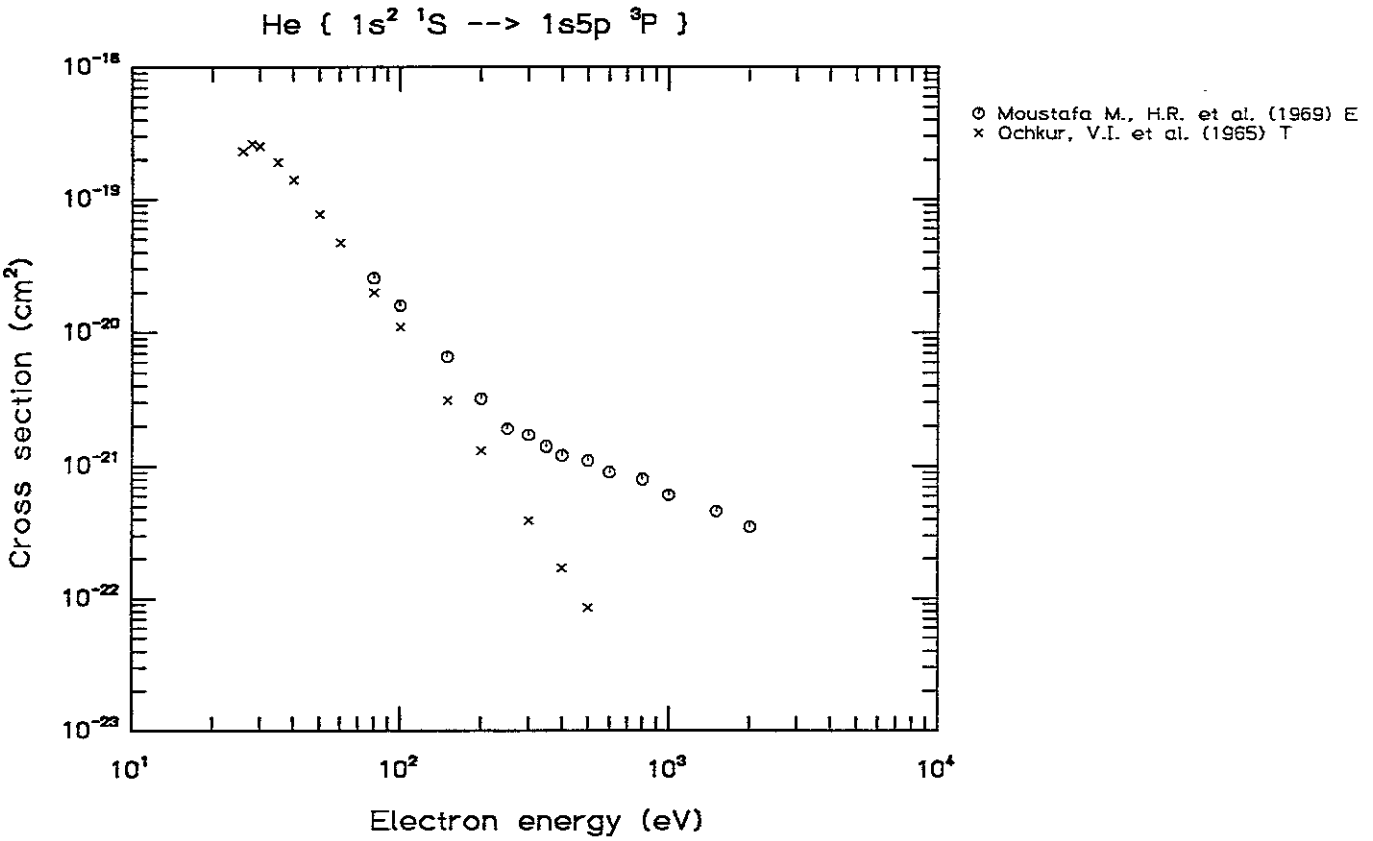
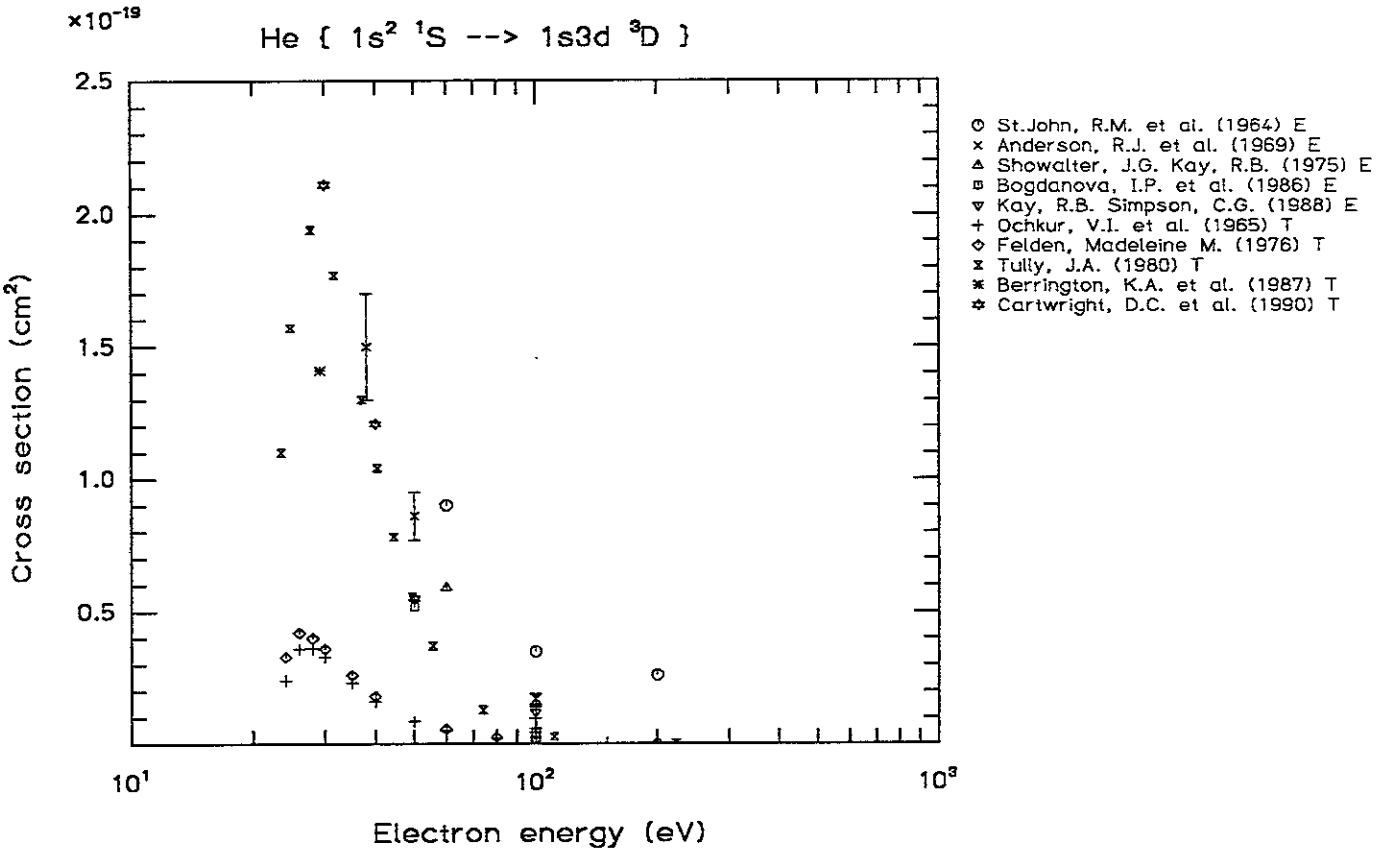
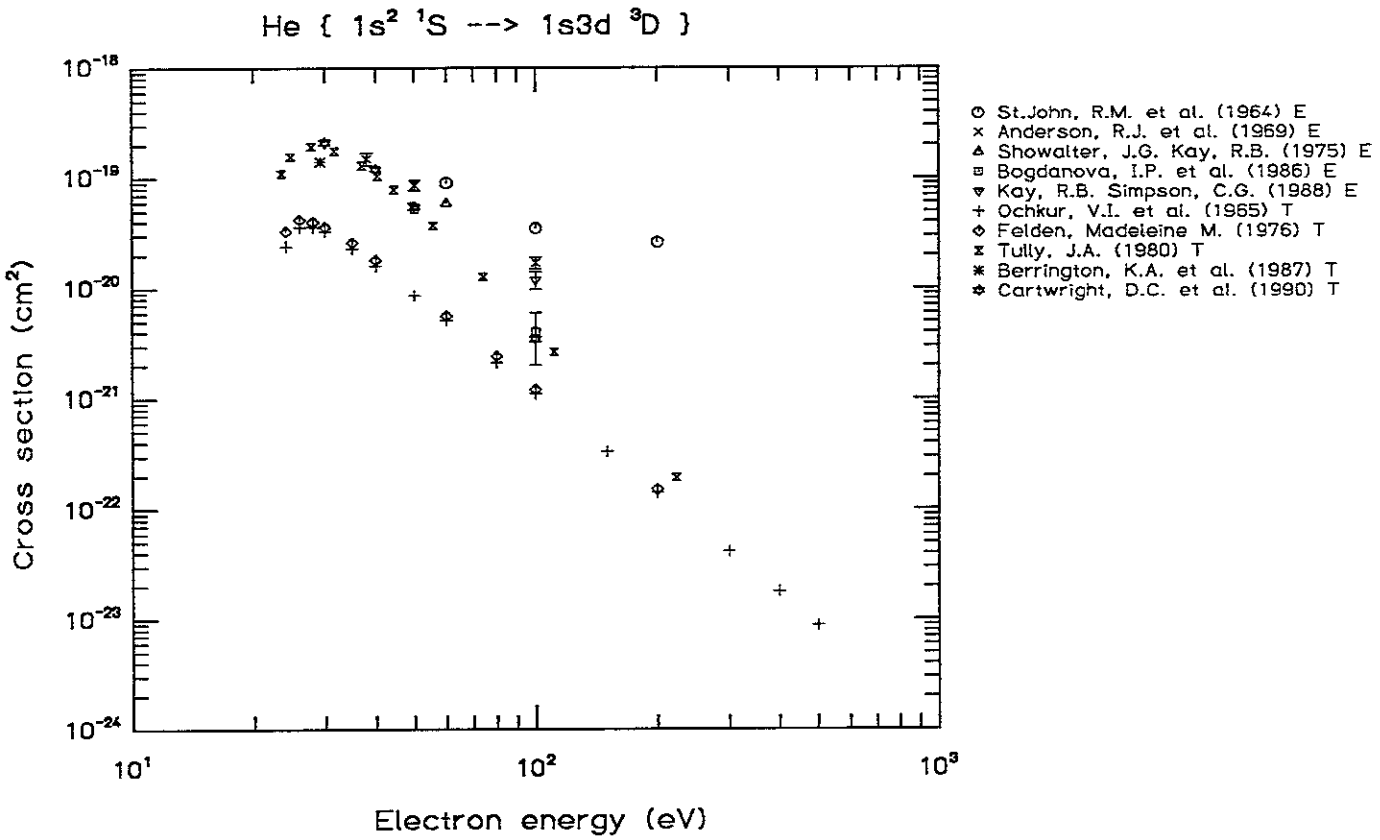
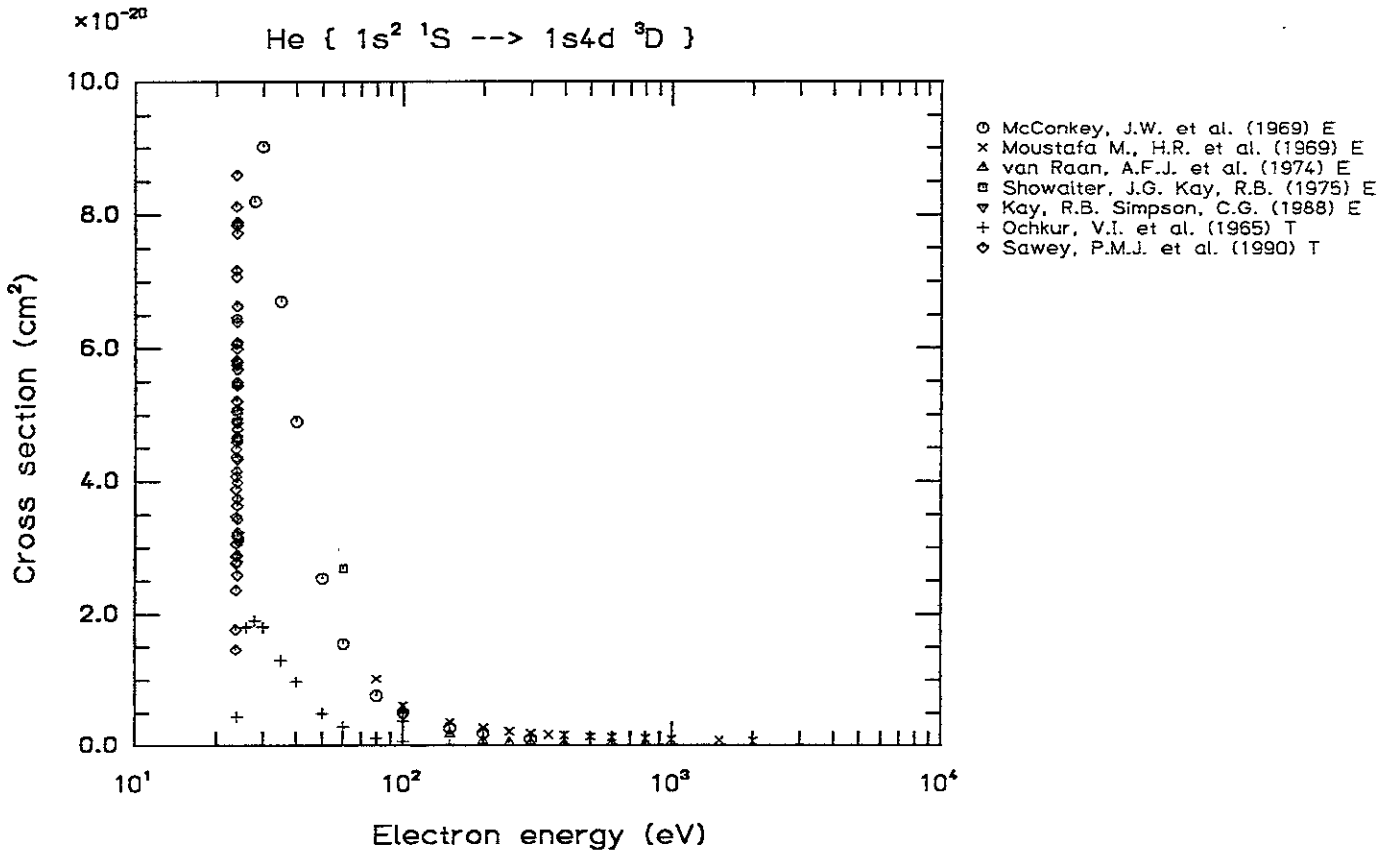
10⁻¹⁸
10⁻¹⁹
10⁻²⁰
10⁻²¹
10⁻²²
Cross section (cm²)
10¹
10²
10³
10⁴
Electron energy (eV)
Moustafa M., H.R. et al. (1969) E
Ochkur, V.I. et al. (1965) T
Sawey, P.M.J. et al. (1990) T
Fon, W.C. et al. (1991) T

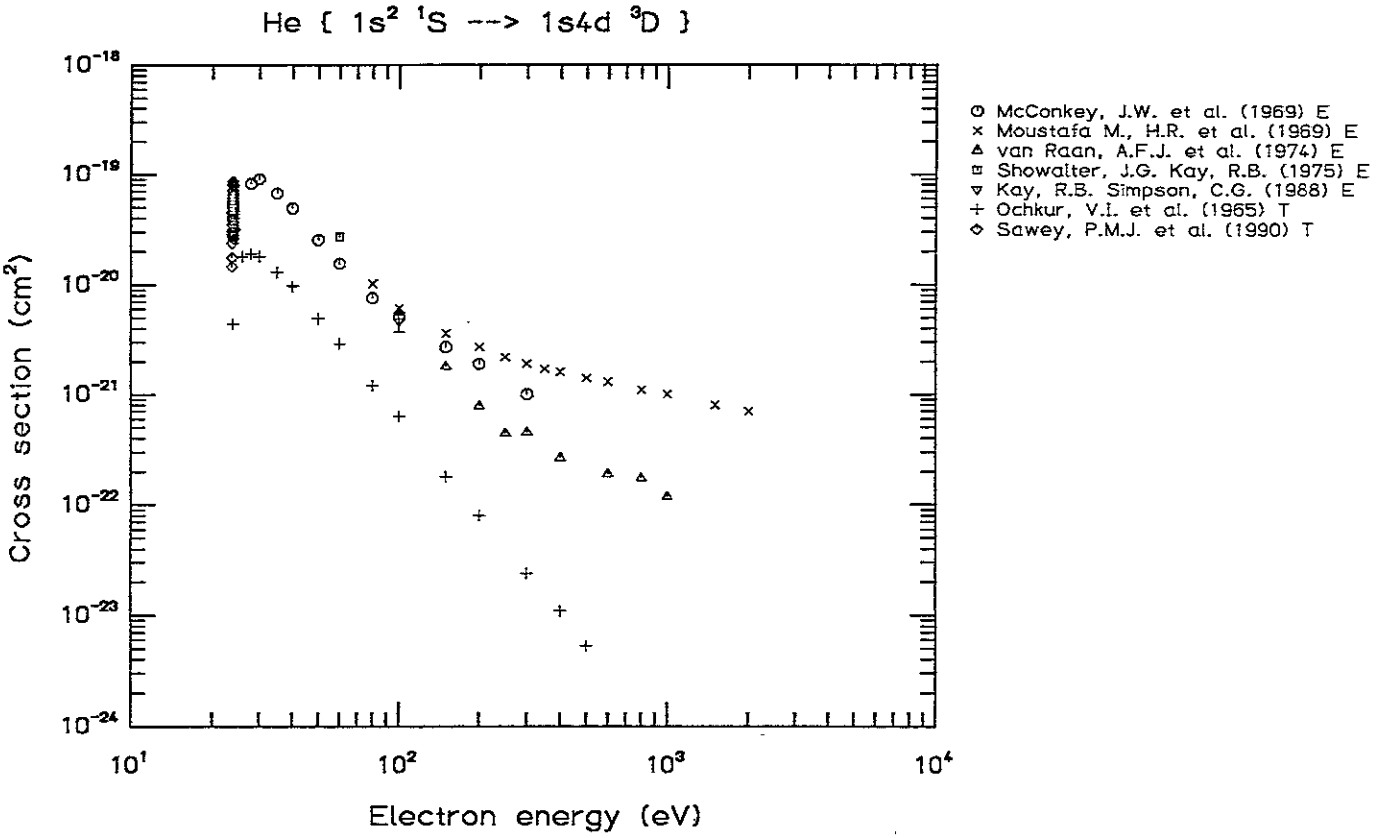

He { 1s² ¹S --> 1s5p ³P }
×10⁻¹⁹
3.0
2.5
2.0
1.5
1.0
0.5
Cross section (cm²)
10¹
10²
10³
10⁴
Electron energy (eV)
⊙ Moustafa M., H.R. et al. (1969) E
× Ochkur, V.I. et al. (1965) T

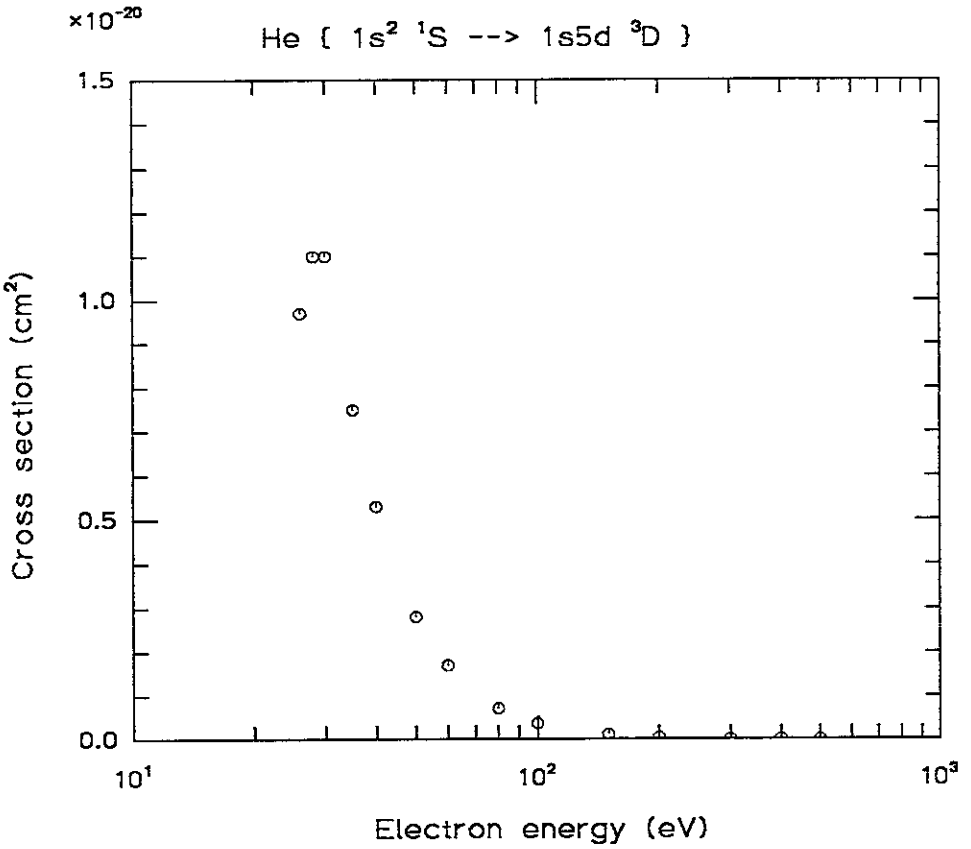

He { 1s² ¹S --> 1s5p ³P }
10⁻¹⁸
10⁻¹⁹
10⁻²⁰
10⁻²¹
10⁻²²
10⁻²³
Cross section (cm²)
10¹
10²
10³
10⁴
Electron energy (eV)
⊙ Moustafa M., H.R. et al. (1969) E
× Ochkur, V.I. et al. (1965) T

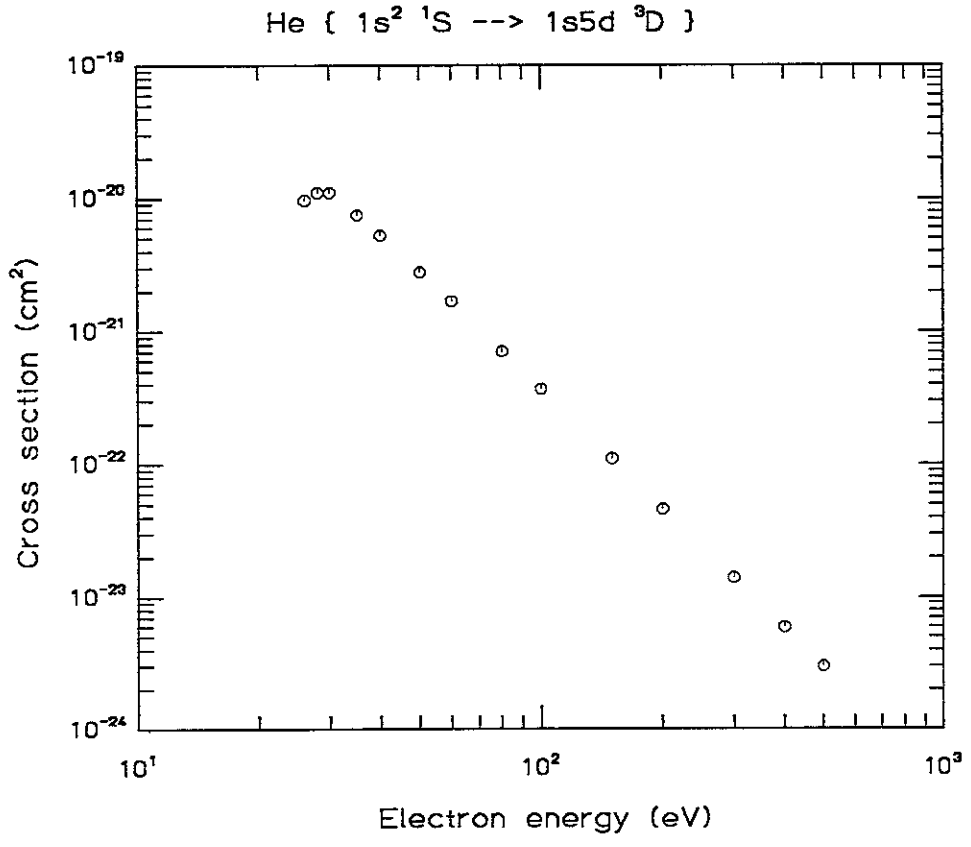

He { 1s² ¹S --> 1s3d ³D }
×10⁻¹⁹
2.5
2.0
1.5
1.0
0.5
Cross section (cm²)
10¹
10²
10³
Electron energy (eV)
St.John, R.M. et al. (1964) E
Anderson, R.J. et al. (1969) E
Showalter, J.G. Kay, R.B. (1975) E
Bogdanova, I.P. et al. (1986) E
Kay, R.B. Simpson, C.G. (1988) E
Ochkur, V.I. et al. (1965) T
Felden, Madeleine M. (1976) T
Tully, J.A. (1980) T
Berrington, K.A. et al. (1987) T
Cartwright, D.C. et al. (1990) T

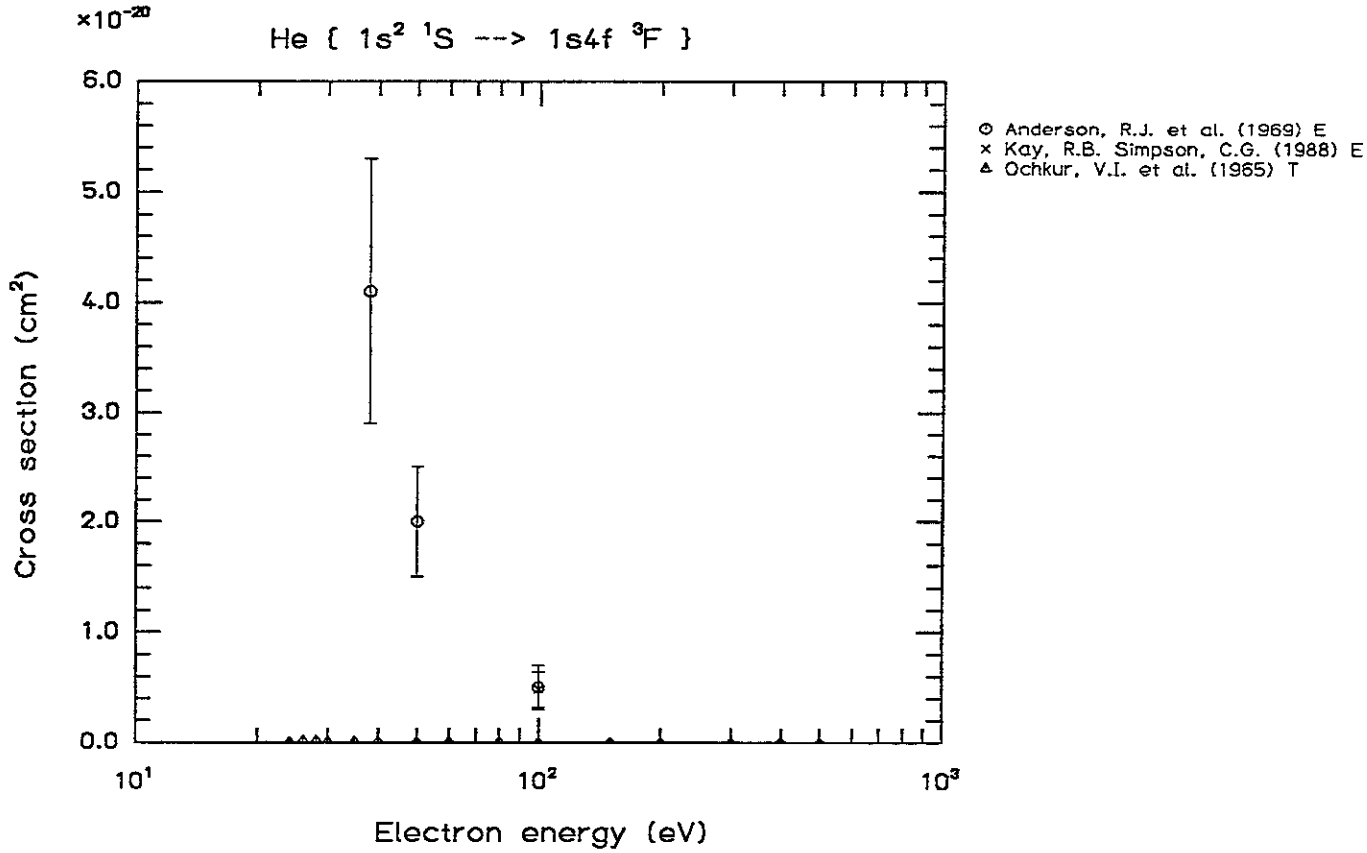

He { 1s² ¹S --> 1s3d ³D }
10⁻¹⁸
10⁻¹⁹
10⁻²⁰
10⁻²¹
10⁻²²
10⁻²³
10⁻²⁴
Cross section (cm²)
10¹
10²
10³
Electron energy (eV)
St.John, R.M. et al. (1964) E
Anderson, R.J. et al. (1969) E
Showalter, J.G. Kay, R.B. (1975) E
Bogdanova, I.P. et al. (1986) E
Kay, R.B. Simpson, C.G. (1988) E
Ochkur, V.I. et al. (1965) T
Felden, Madeleine M. (1976) T
Tully, J.A. (1980) T
Berrington, K.A. et al. (1987) T
Cartwright, D.C. et al. (1990) T

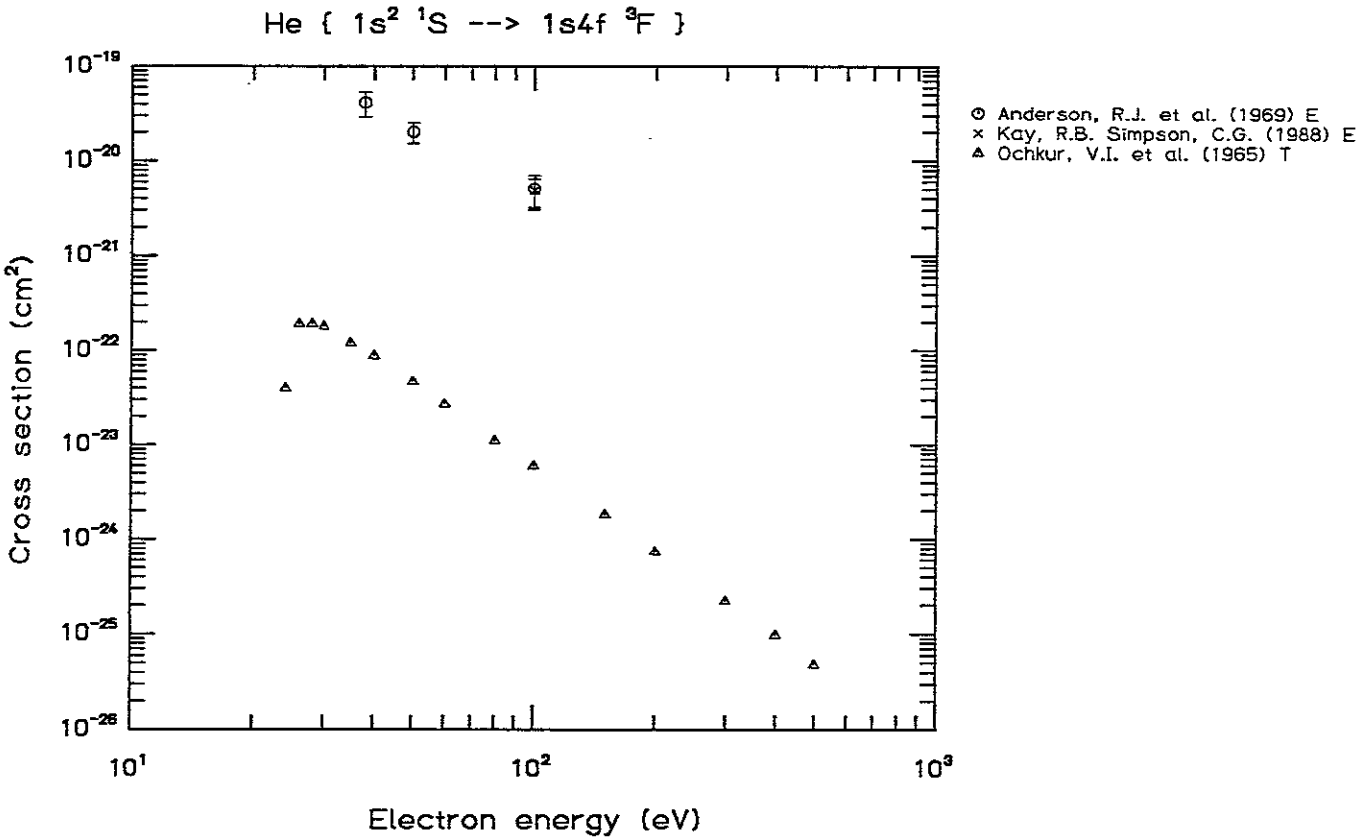

He { 1s² ¹S --> 1s4d ³D }
×10⁻²⁰
10.0
8.0
6.0
4.0
2.0
0.0
Cross section (cm²)
10¹
10²
10³
10⁴
Electron energy (eV)
McConkey, J.W. et al. (1969) E
Moustafa M., H.R. et al. (1969) E
van Raan, A.F.J. et al. (1974) E
Showalter, J.G. Kay, R.B. (1975) E
Kay, R.B. Simpson, C.G. (1988) E
Ochkur, V.I. et al. (1965) T
Sawey, P.M.J. et al. (1990) T

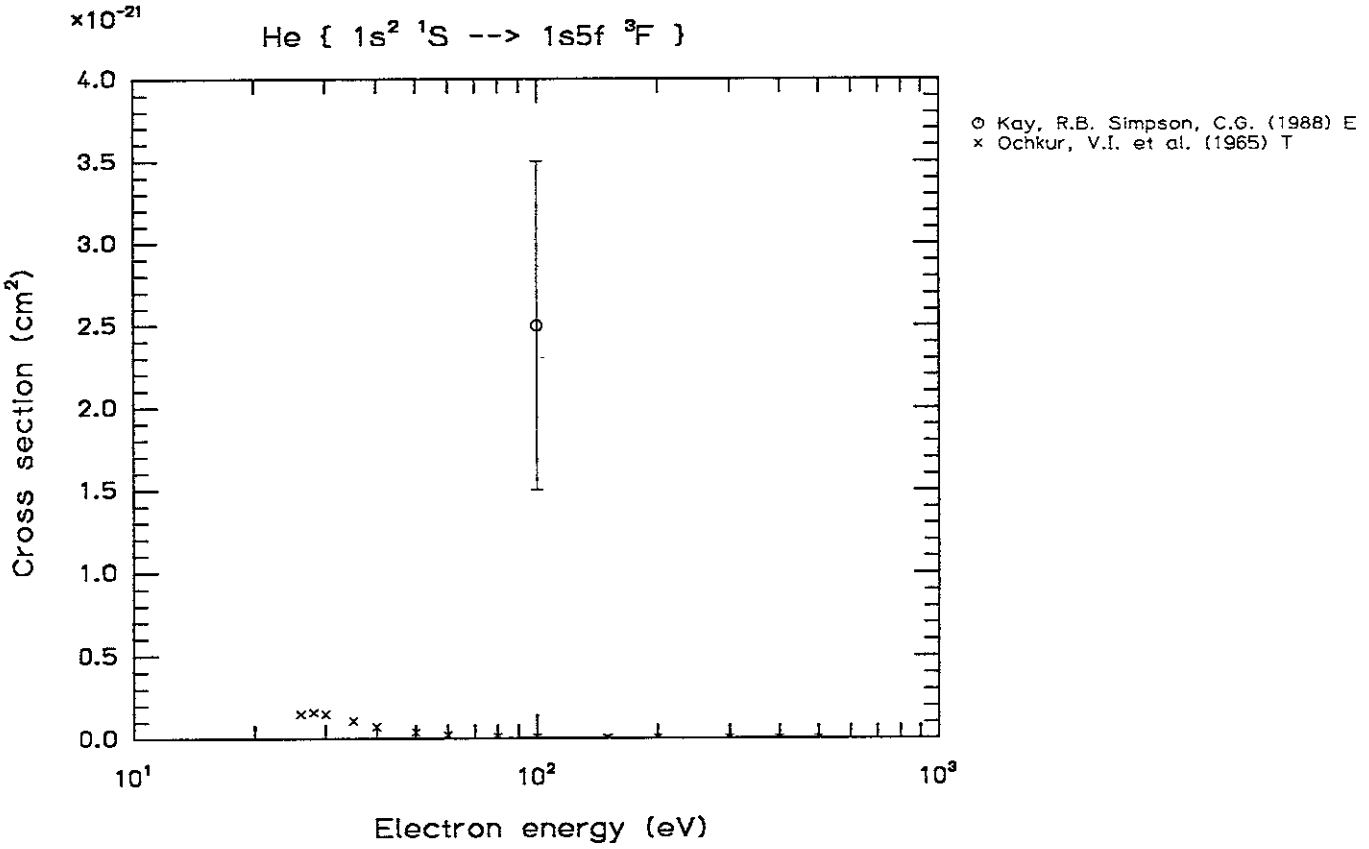

He { 1s² ¹S --> 1s4d ³D }
10⁻¹⁸
10⁻¹⁹
10⁻²⁰
10⁻²¹
10⁻²²
10⁻²³
10⁻²⁴
Cross section (cm²)
10¹
10²
10³
10⁴
Electron energy (eV)
McConkey, J.W. et al. (1969) E
Moustafa M., H.R. et al. (1969) E
van Raan, A.F.J. et al. (1974) E
Showalter, J.G. Kay, R.B. (1975) E
Kay, R.B. Simpson, C.G. (1988) E
Ochkur, V.I. et al. (1965) T
Sawey, P.M.J. et al. (1990) T

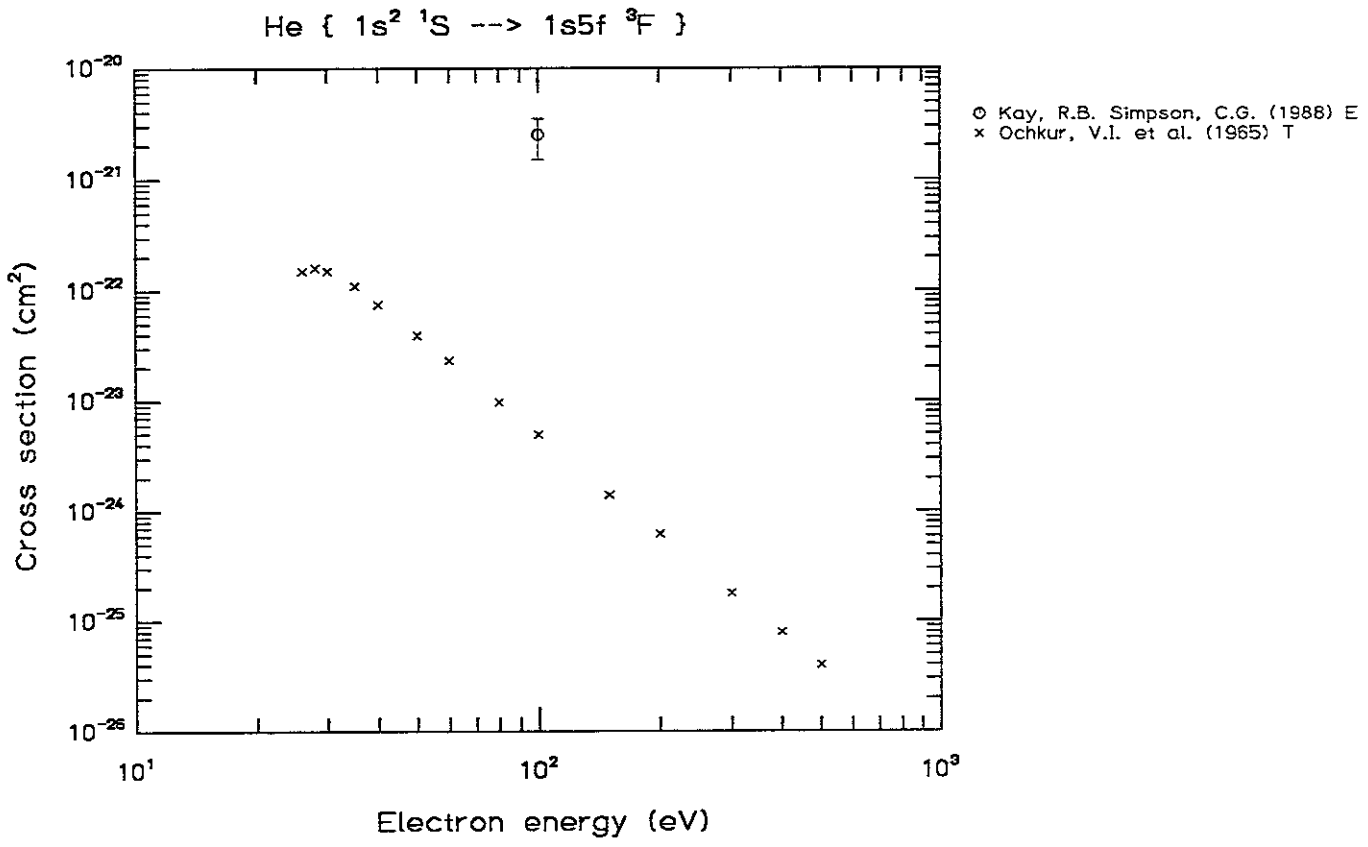

He { 1s² ¹S --> 1s5d ³D }
×10⁻²⁰
1.5
1.0
0.5
0.0
Cross section (cm²)
10¹
10²
10³
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1965) T

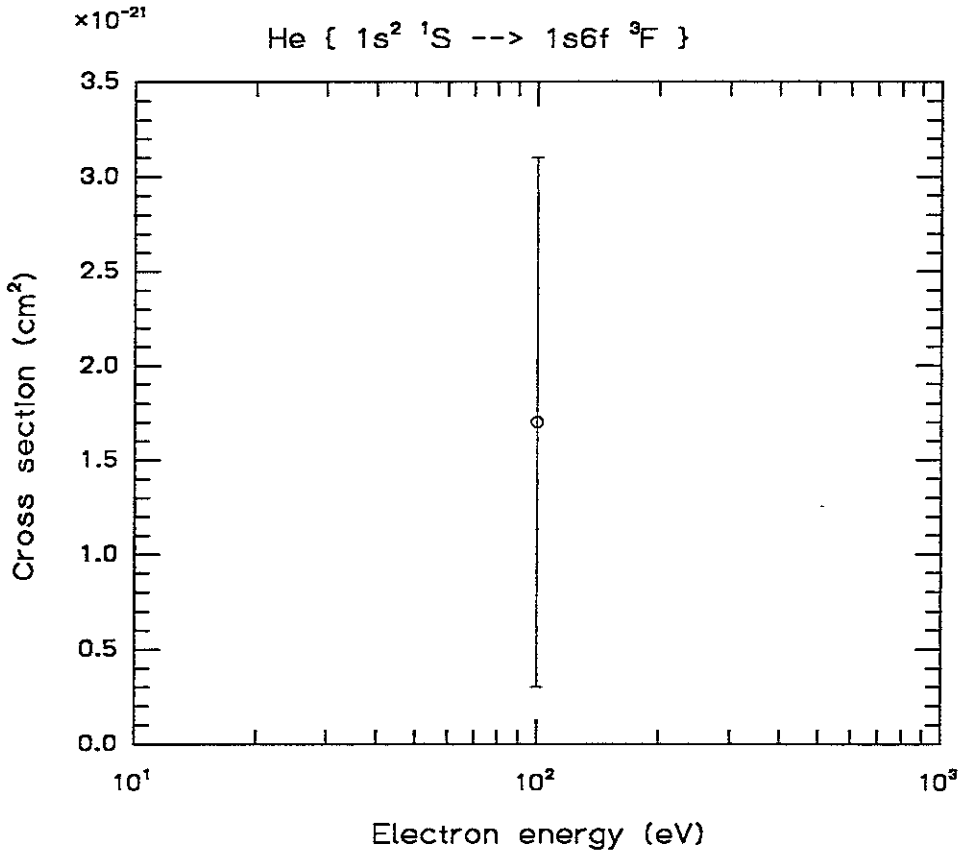

He { 1s² ¹S --> 1s5d ³D }
10⁻¹⁹
10⁻²⁰
10⁻²¹
10⁻²²
10⁻²³
10⁻²⁴
Cross section (cm²)
10¹
10²
10³
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1965) T


He { 1s² ¹S --> 1s4f ³F }
×10⁻²⁰
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Cross section (cm²)
10¹
10²
10³
Electron energy (eV)
⊙ Anderson, R.J. et al. (1969) E
× Kay, R.B. Simpson, C.G. (1988) E
△ Ochkur, V.I. et al. (1965) T

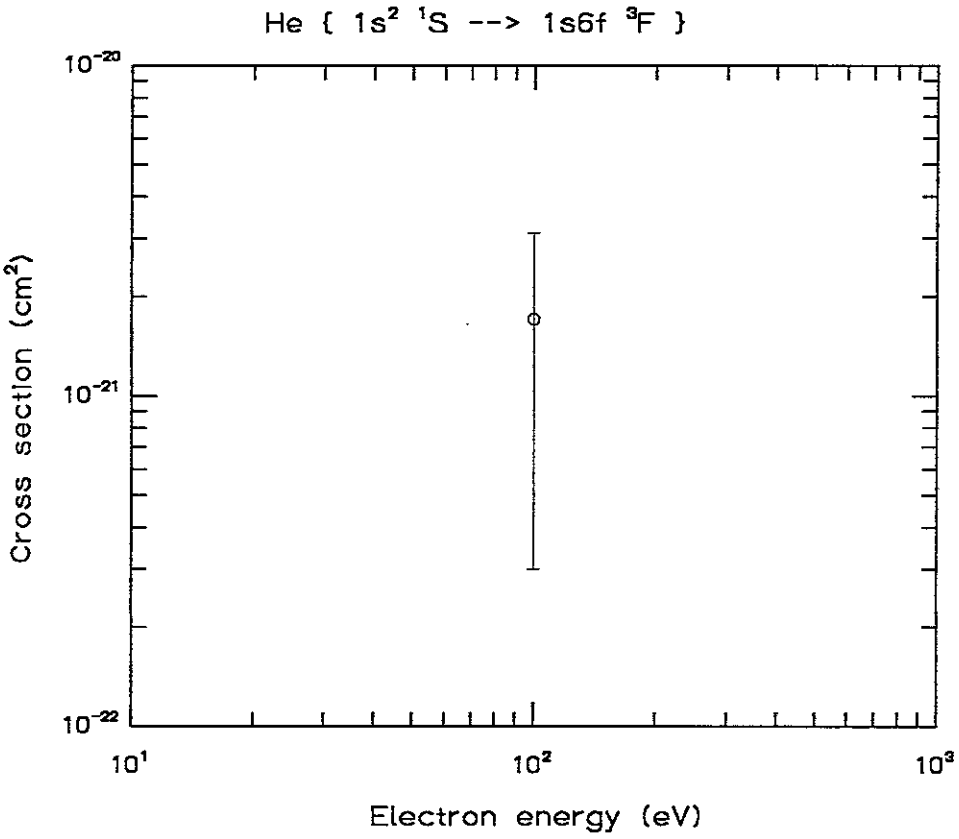

He { 1s² ¹S --> 1s4f ³F }
10⁻¹⁹
10⁻²⁰
10⁻²¹
10⁻²²
10⁻²³
10⁻²⁴
10⁻²⁵
10⁻²⁶
Cross section (cm²)
10¹
10²
10³
Electron energy (eV)
⊙ Anderson, R.J. et al. (1969) E
× Kay, R.B. Simpson, C.G. (1988) E
△ Ochkur, V.I. et al. (1965) T


He { 1s² ¹S --> 1s5f ³F }
×10⁻²¹
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Cross section (cm²)
10¹
10²
10³
Electron energy (eV)
⊙ Kay, R.B. Simpson, C.G. (1988) E
× Ochkur, V.I. et al. (1965) T

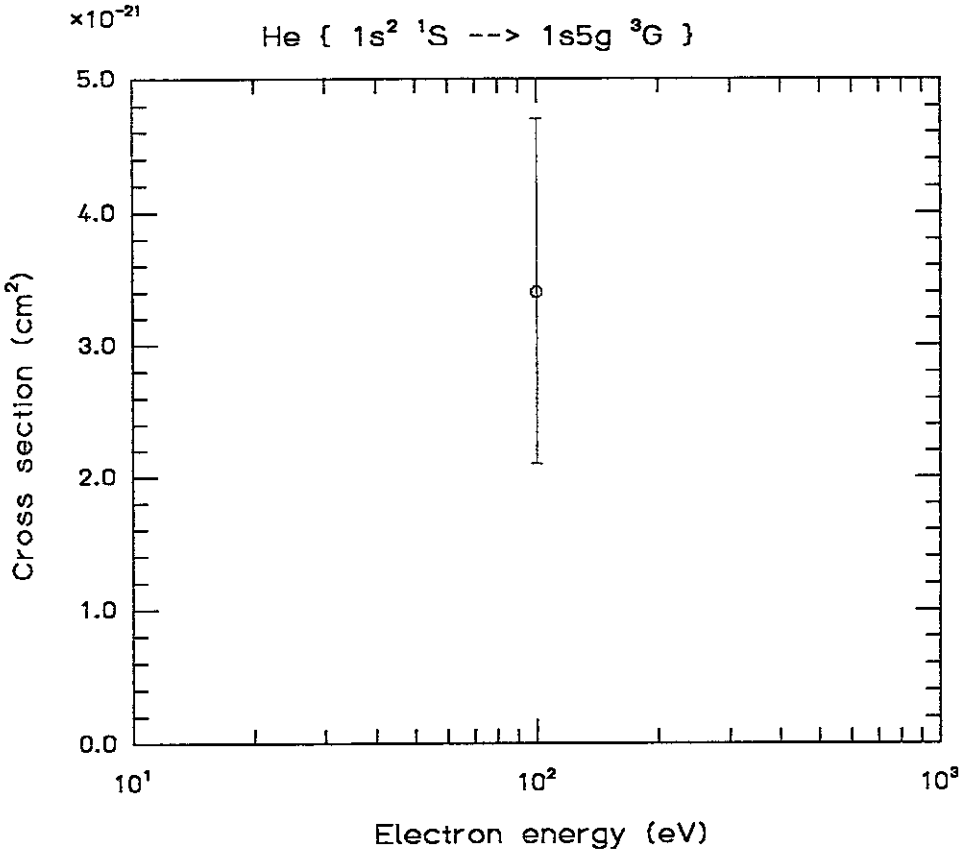

He { 1s² ¹S --> 1s5f ³F }
10⁻²⁰
10⁻²¹
10⁻²²
10⁻²³
10⁻²⁴
10⁻²⁵
10⁻²⁶
Cross section (cm²)
10¹
10²
10³
Electron energy (eV)
⊙ Kay, R.B. Simpson, C.G. (1988) E
× Ochkur, V.I. et al. (1965) T



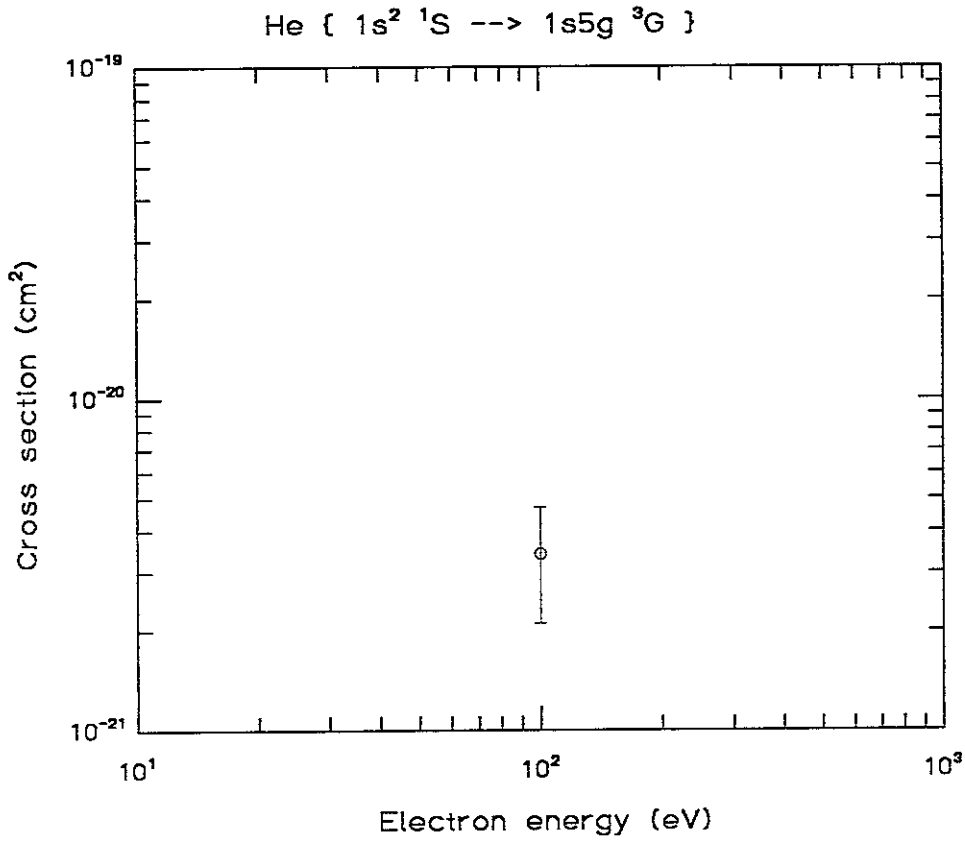

© Kay, R.B. Simpson, C.G. (1988) E

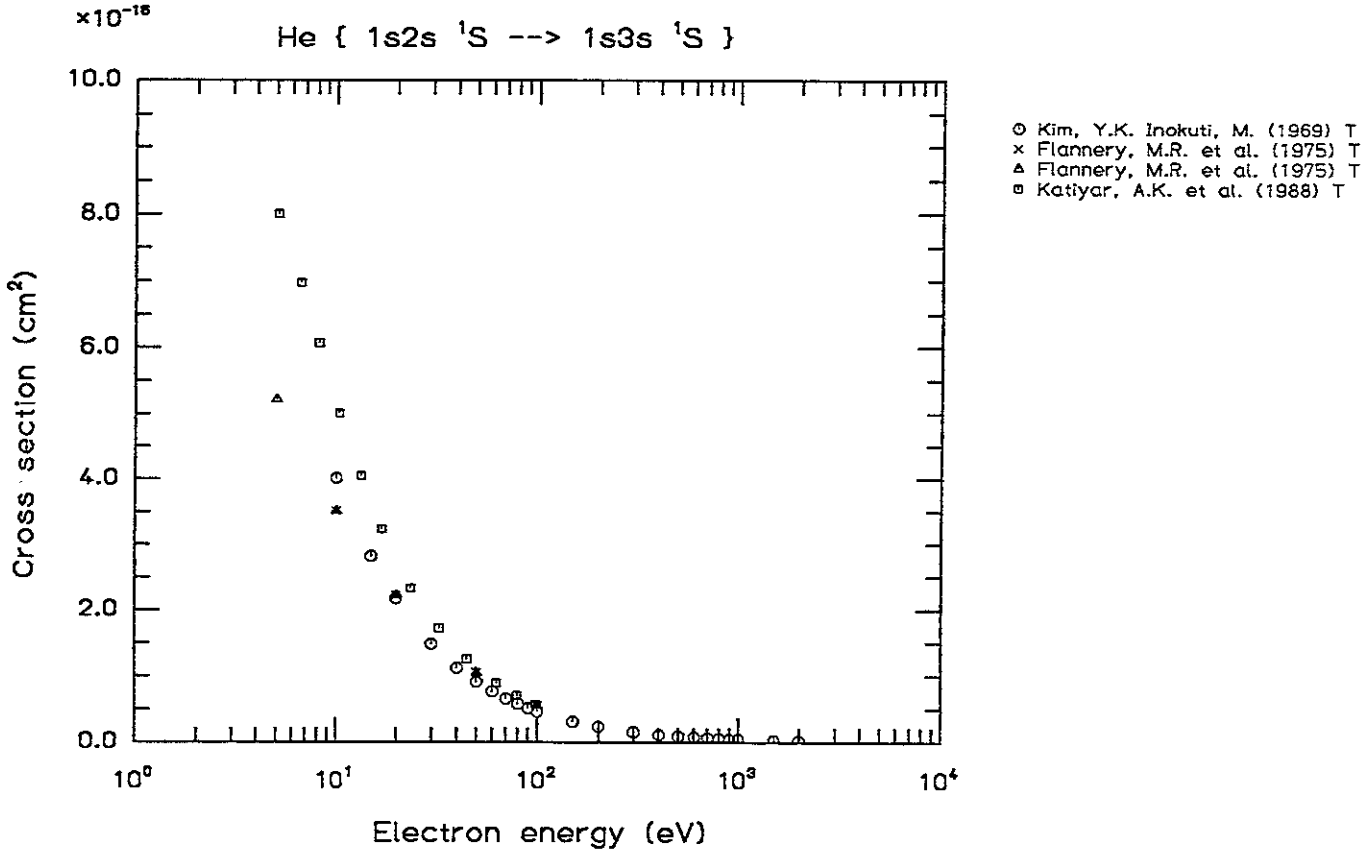


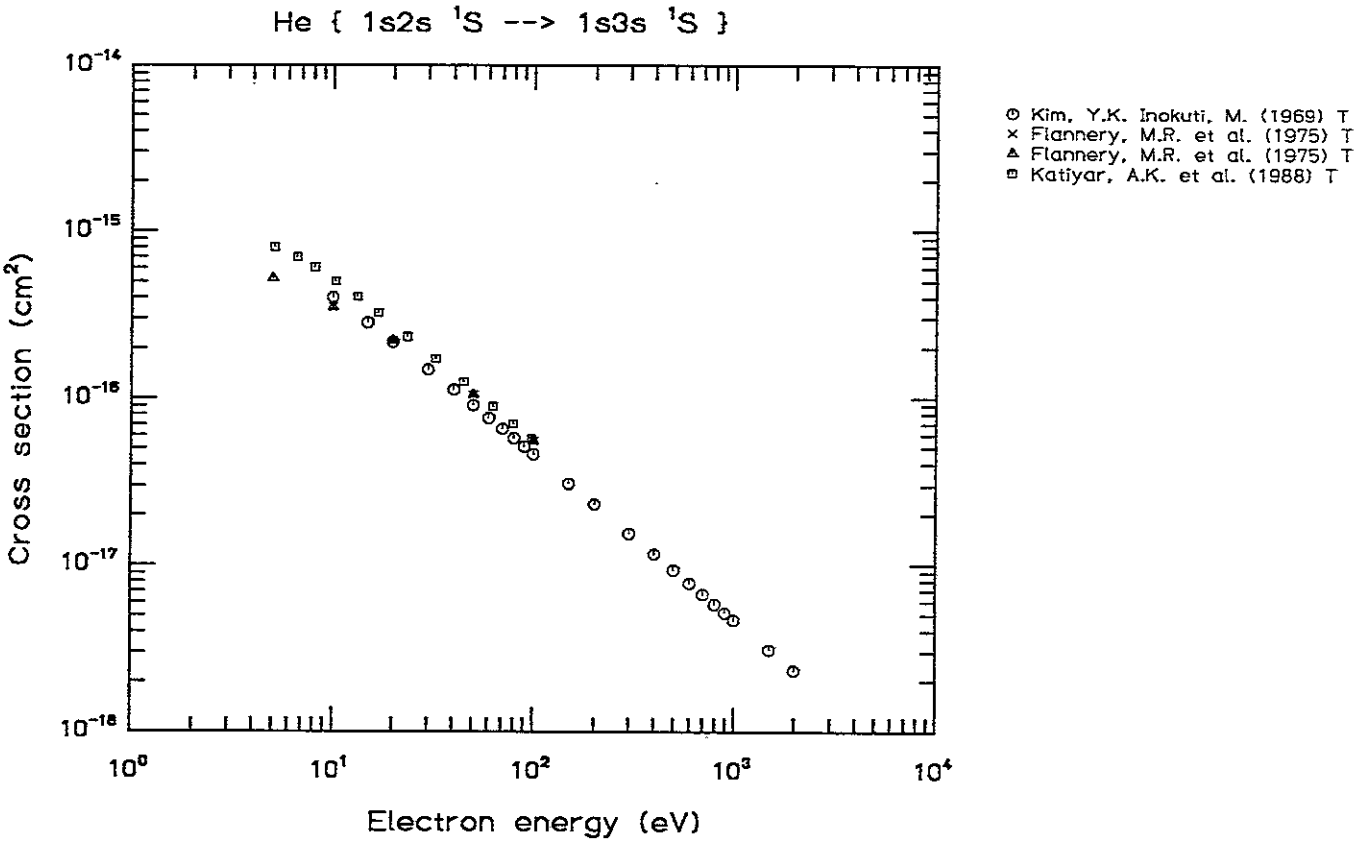

© Kay, R.B. Simpson, C.G. (1988) E

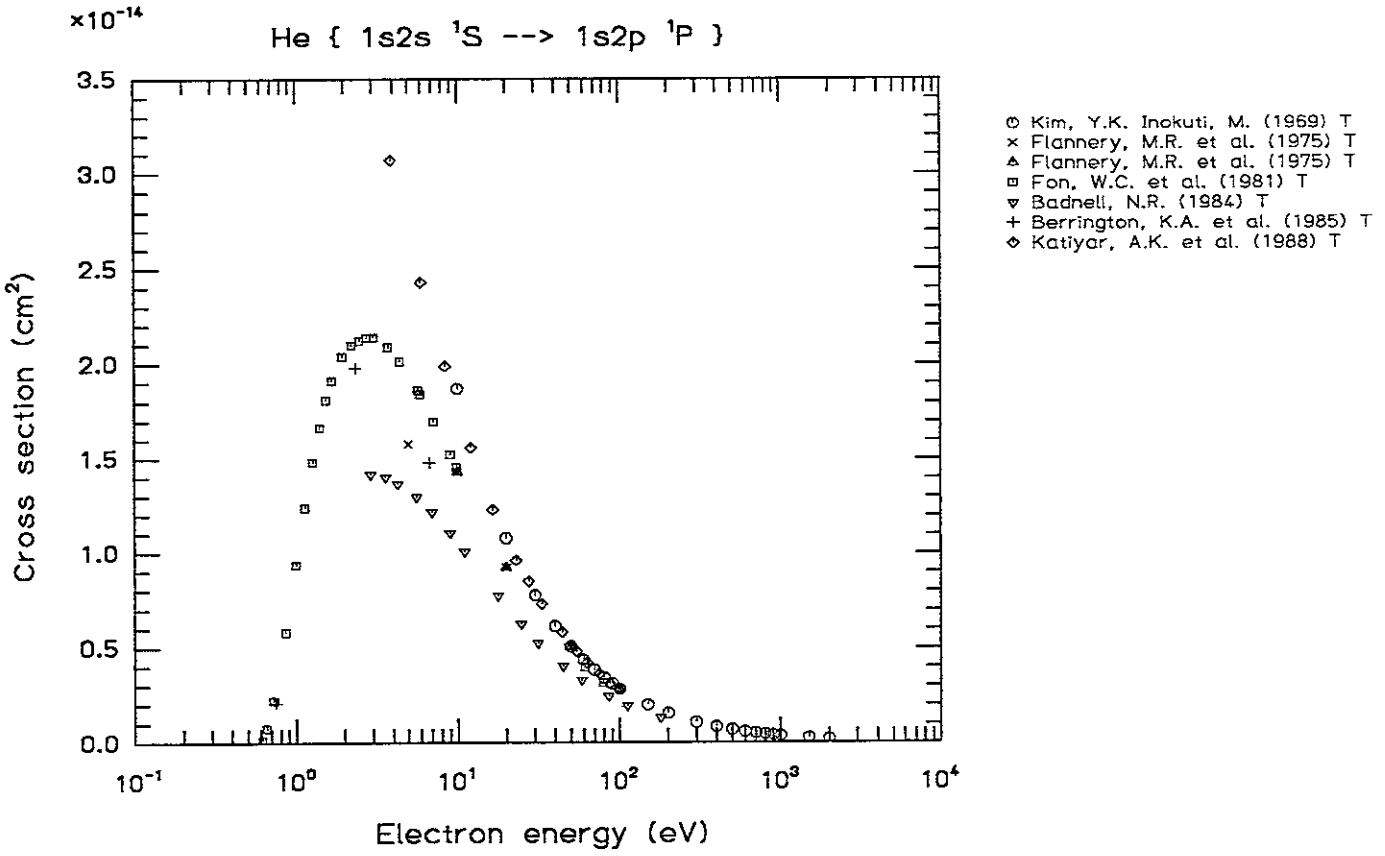


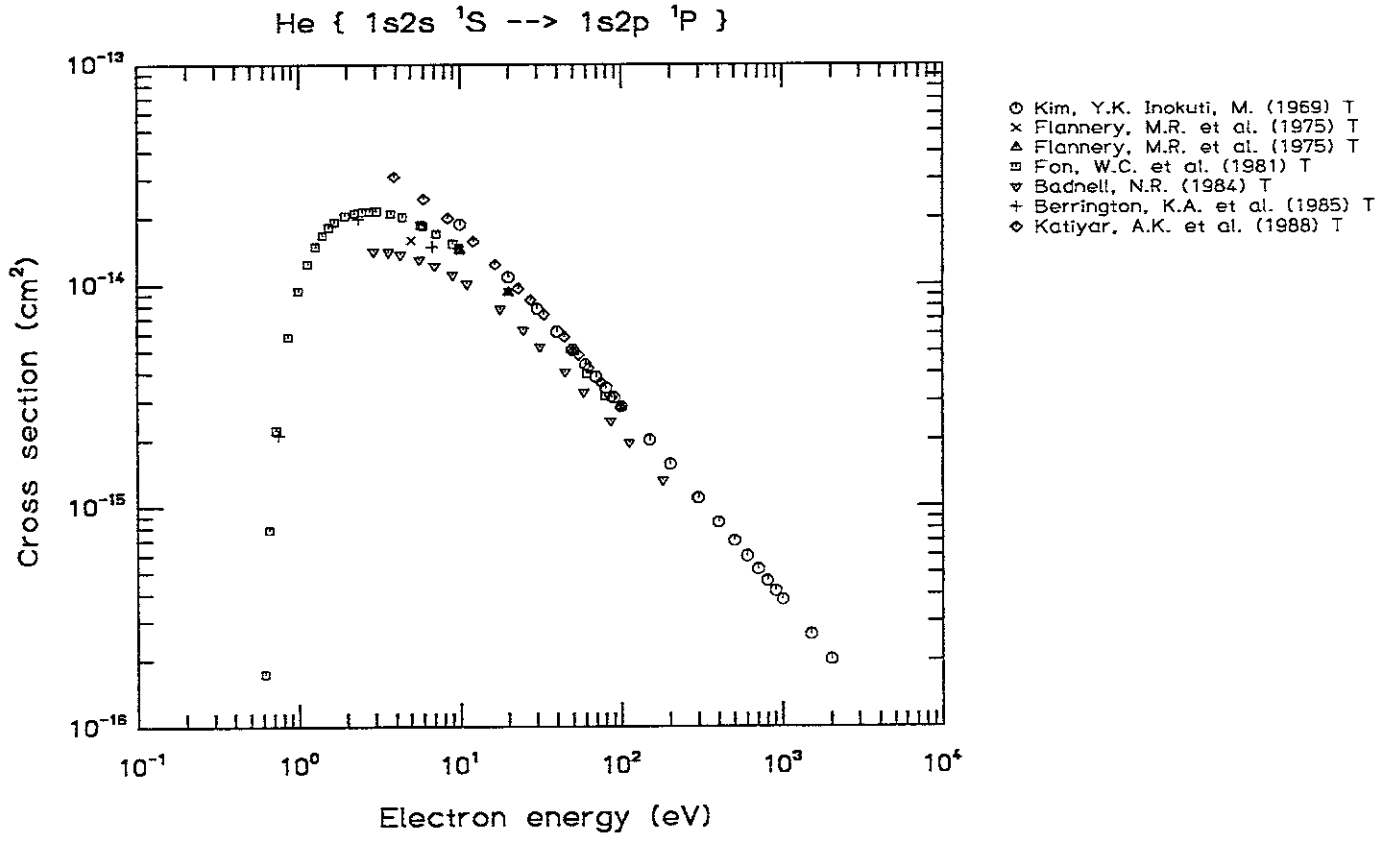


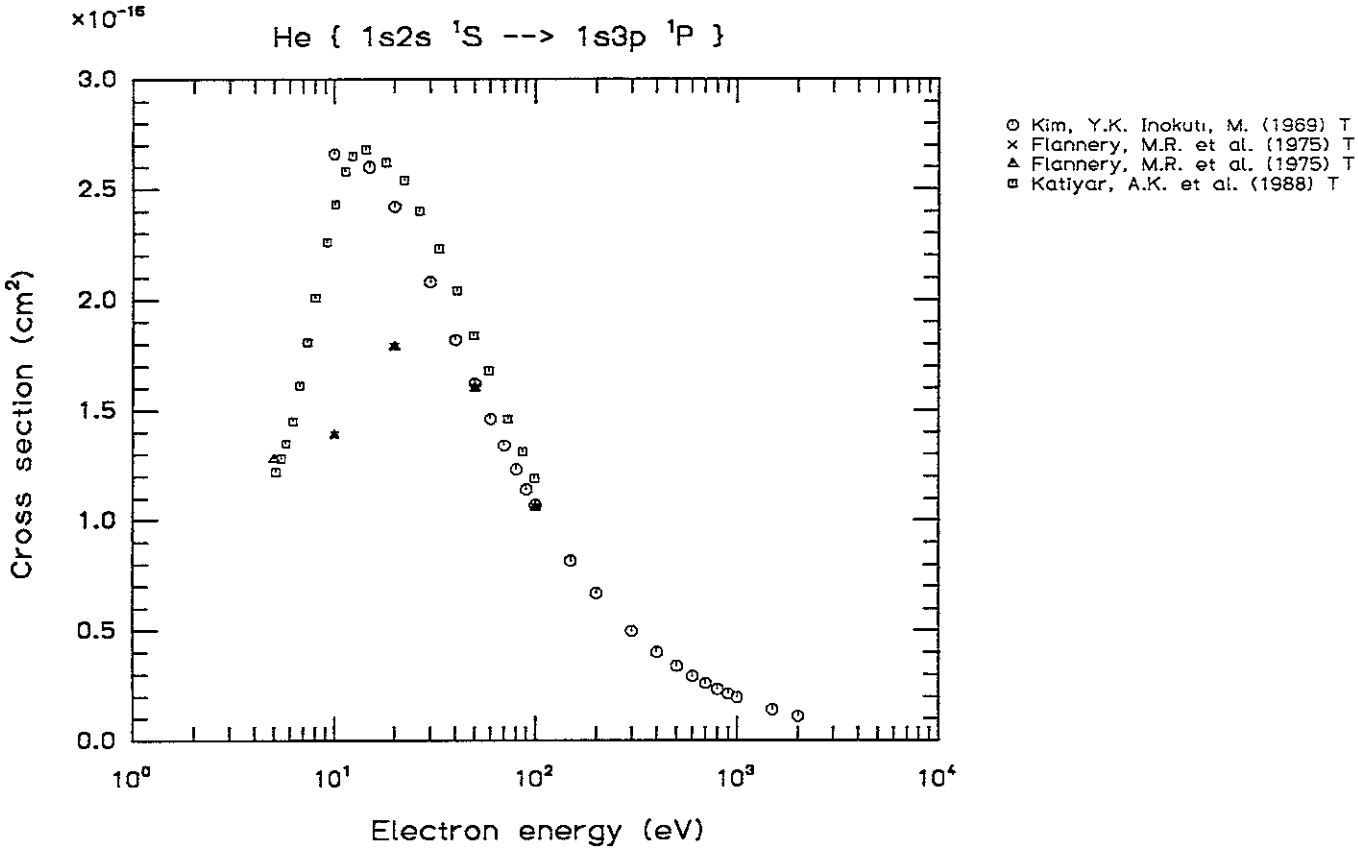



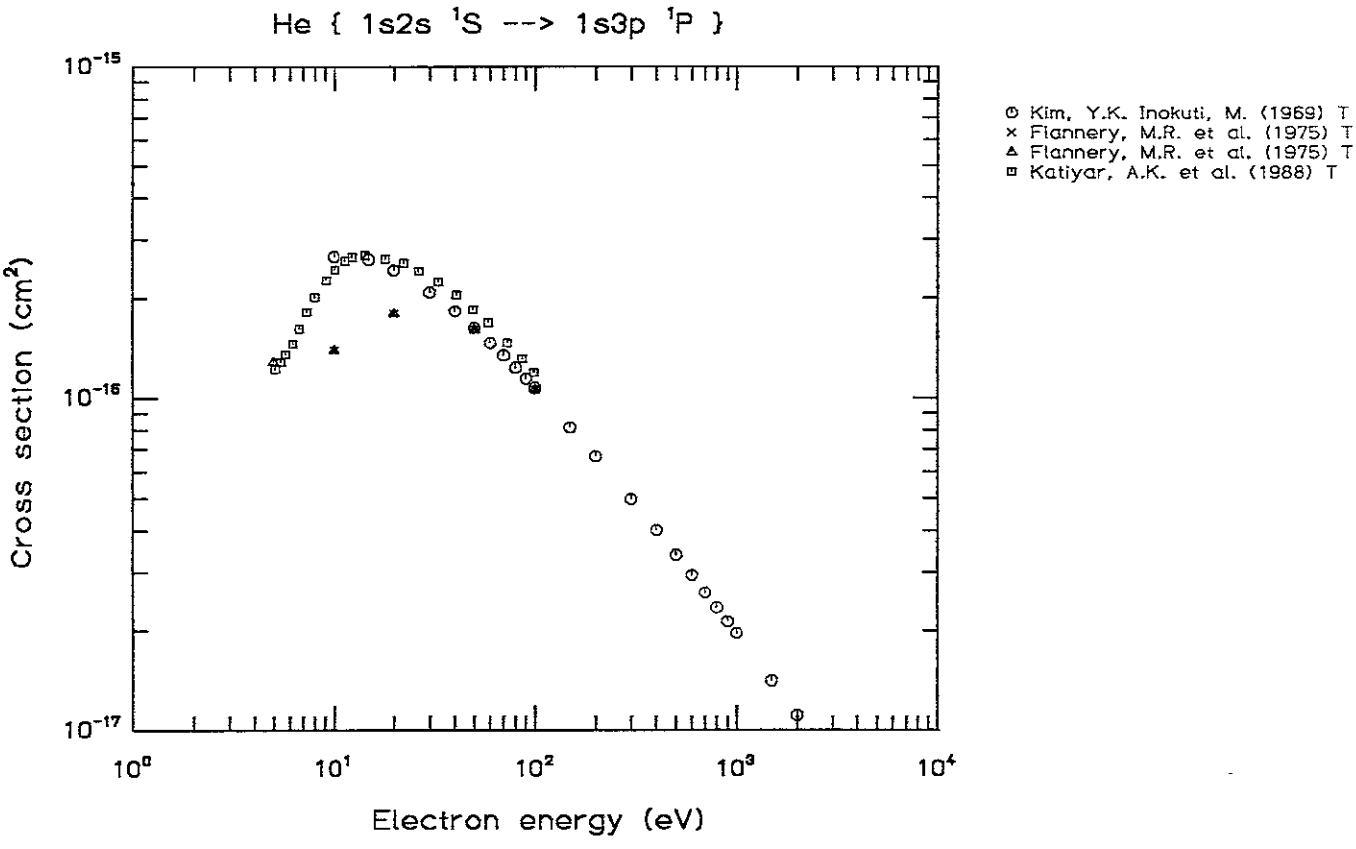

He { 1s2s ¹S --> 1s3s ¹S }
×10⁻¹⁵
10.0
8.0
6.0
4.0
2.0
0.0
Cross section (cm²)
10⁰
10¹
10²
10³
10⁴
Electron energy (eV)
⊙ Kim, Y.K. Inokuti, M. (1969) T
× Flannery, M.R. et al. (1975) T
△ Flannery, M.R. et al. (1975) T
⊡ Katiyar, A.K. et al. (1988) T

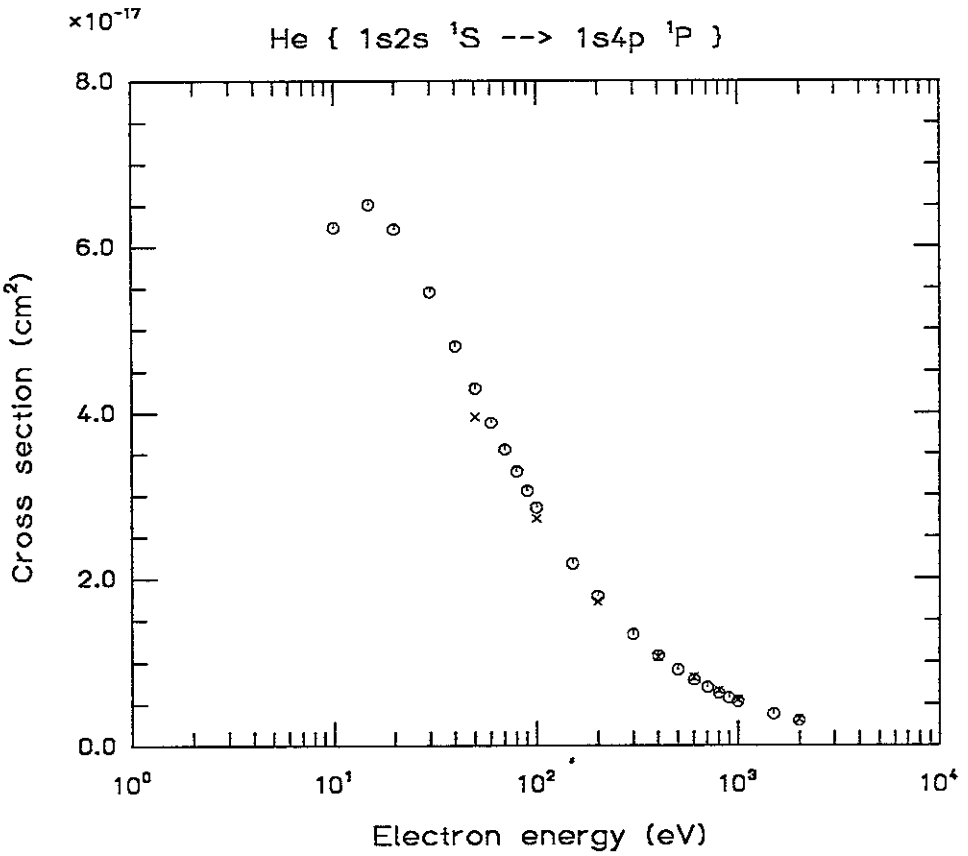

He { 1s2s ¹S --> 1s3s ¹S }
10⁻¹⁴
10⁻¹⁵
10⁻¹⁶
10⁻¹⁷
10⁻¹⁸
Cross section (cm²)
10⁰
10¹
10²
10³
10⁴
Electron energy (eV)
⊙ Kim, Y.K. Inokuti, M. (1969) T
× Flannery, M.R. et al. (1975) T
△ Flannery, M.R. et al. (1975) T
⊡ Katiyar, A.K. et al. (1988) T


He { 1s2s ¹S --> 1s2p ¹P }
×10⁻¹⁴
Cross section (cm²)
Electron energy (eV)
Kim, Y.K. Inokuti, M. (1969) T
Flannery, M.R. et al. (1975) T
Flannery, M.R. et al. (1975) T
Fon, W.C. et al. (1981) T
Badnell, N.R. (1984) T
Berrington, K.A. et al. (1985) T
Katiyar, A.K. et al. (1988) T

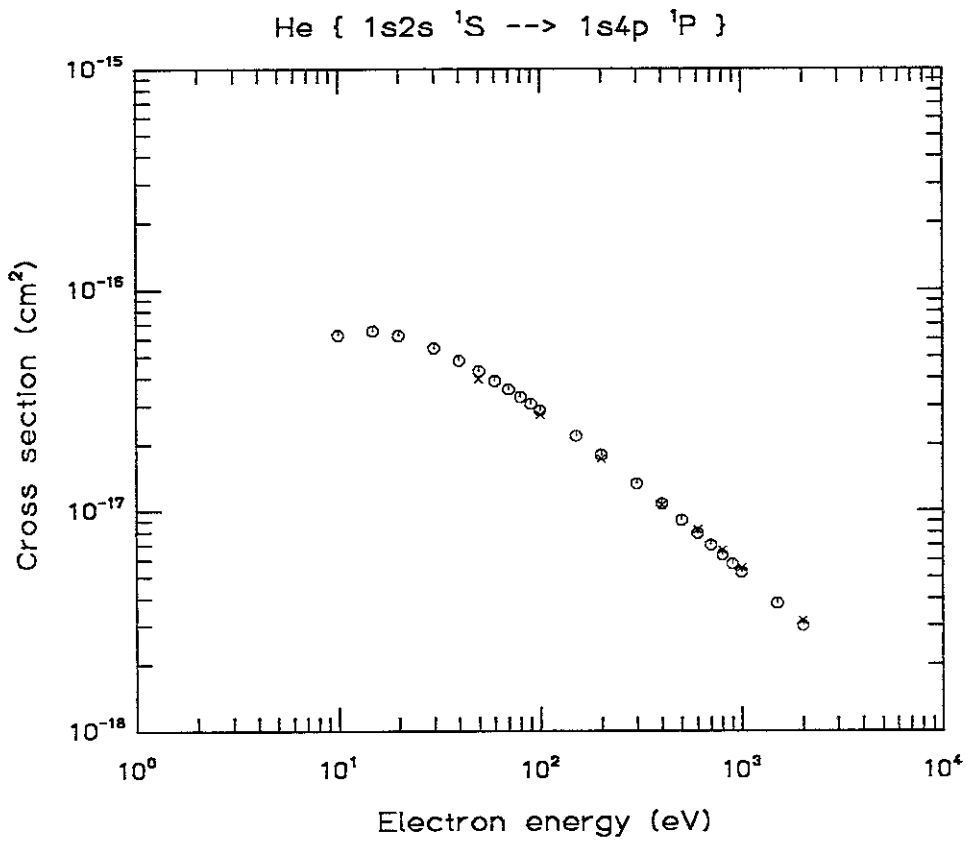

He { 1s2s ¹S --> 1s2p ¹P }
Cross section (cm²)
Electron energy (eV)
Kim, Y.K. Inokuti, M. (1969) T
Flannery, M.R. et al. (1975) T
Flannery, M.R. et al. (1975) T
Fon, W.C. et al. (1981) T
Badnell, N.R. (1984) T
Berrington, K.A. et al. (1985) T
Katiyar, A.K. et al. (1988) T


He { 1s2s ¹S --> 1s3p ¹P }
×10⁻¹⁶
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Cross section (cm²)
10⁰
10¹
10²
10³
10⁴
Electron energy (eV)
⊙ Kim, Y.K. Inokuti, M. (1969) T
× Flannery, M.R. et al. (1975) T
△ Flannery, M.R. et al. (1975) T
⊡ Katiyar, A.K. et al. (1988) T

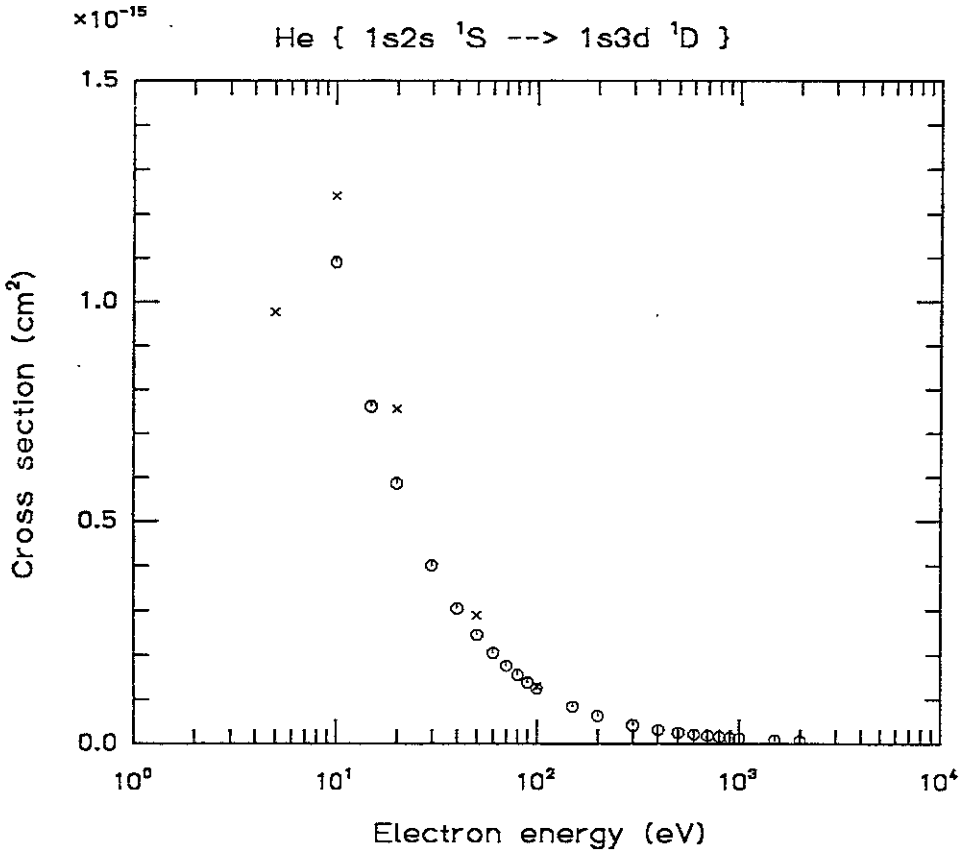

He { 1s2s ¹S --> 1s3p ¹P }
10⁻¹⁵
10⁻¹⁶
10⁻¹⁷
Cross section (cm²)
10⁰
10¹
10²
10³
10⁴
Electron energy (eV)
⊙ Kim, Y.K. Inokuti, M. (1969) T
× Flannery, M.R. et al. (1975) T
△ Flannery, M.R. et al. (1975) T
⊡ Katiyar, A.K. et al. (1988) T



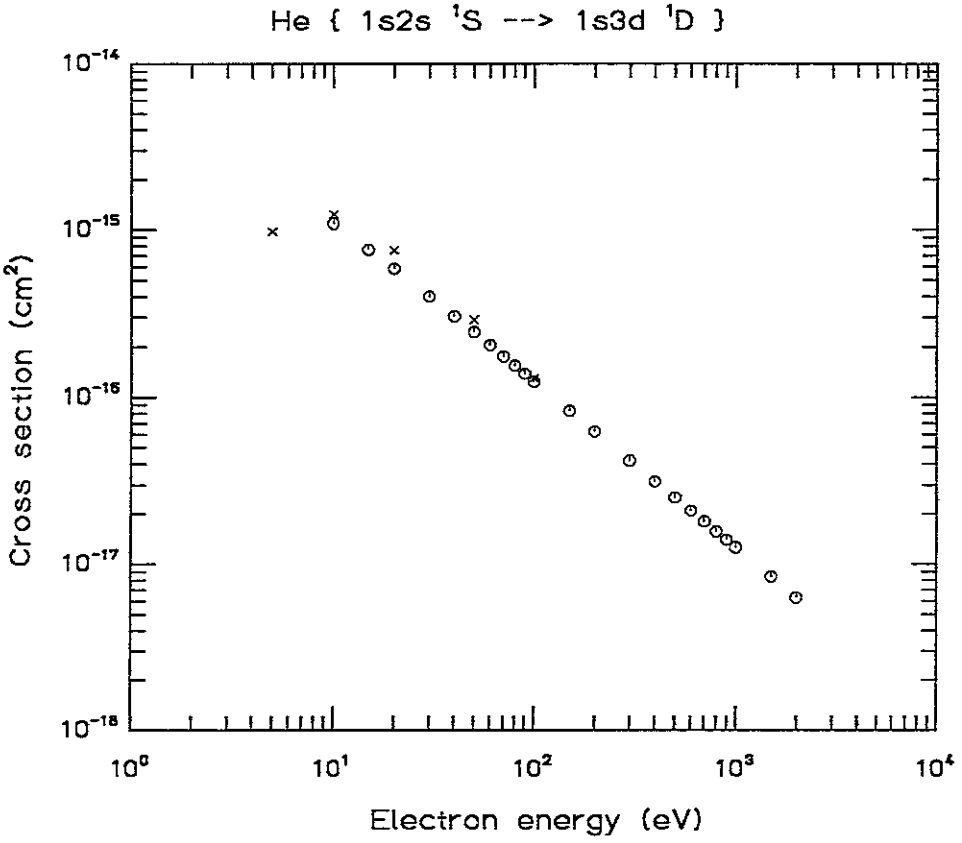

⊙ Kim, Y.K. Inokuti, M. (1969) T
× Vanderpoorten, R. (1970) T



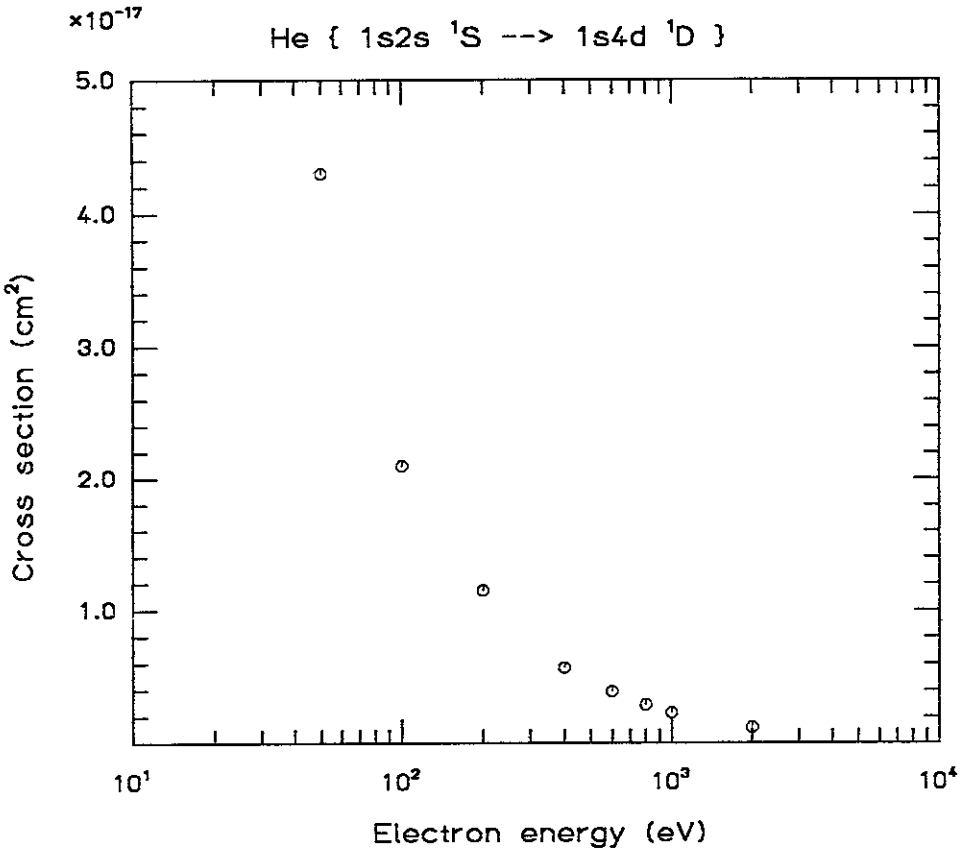

⊙ Kim, Y.K. Inokuti, M. (1969) T
× Vanderpoorten, R. (1970) T



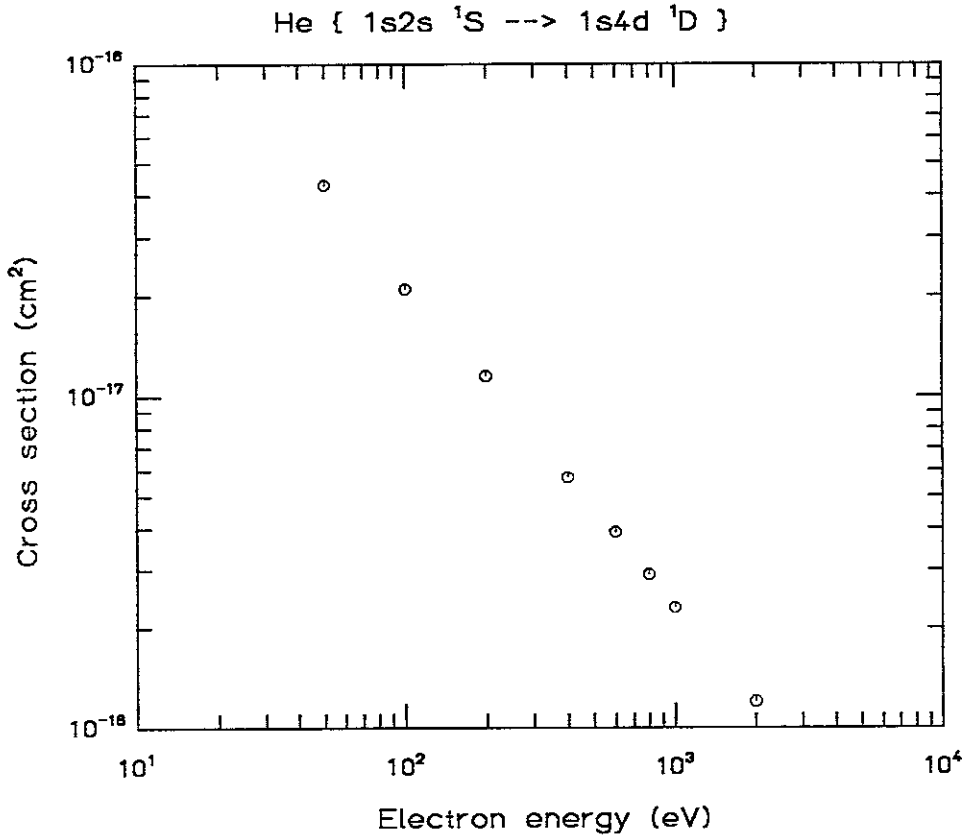

⊙ Kim, Y.K. Inokuti, M. (1969) T
× Flannery, M.R. et al. (1975) T




⊙ Kim, Y.K. Inokuti, M. (1969) T
× Flannery, M.R. et al. (1975) T




⊙ Vanderpoorten, R. (1970) T

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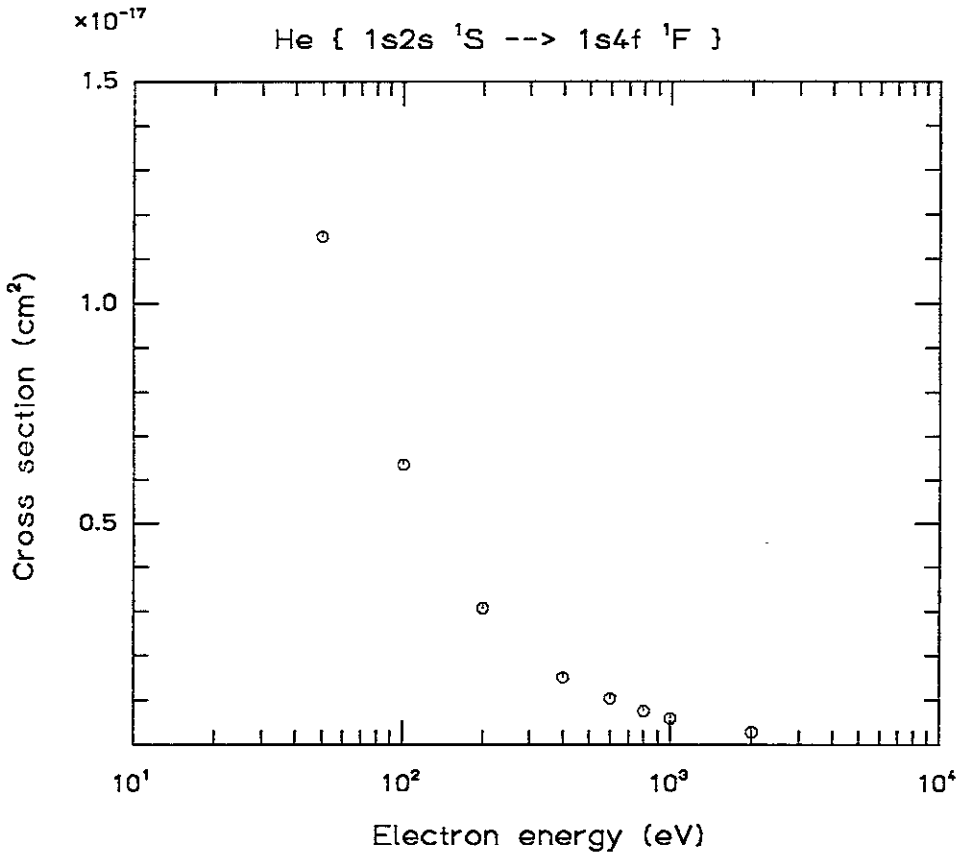
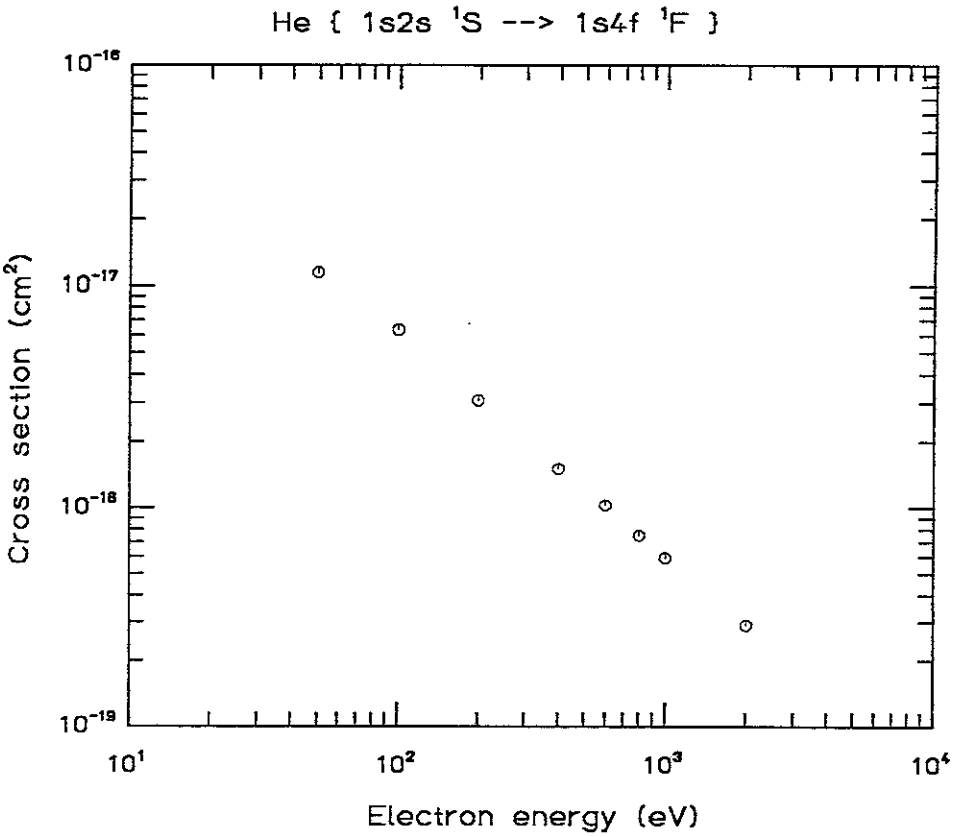
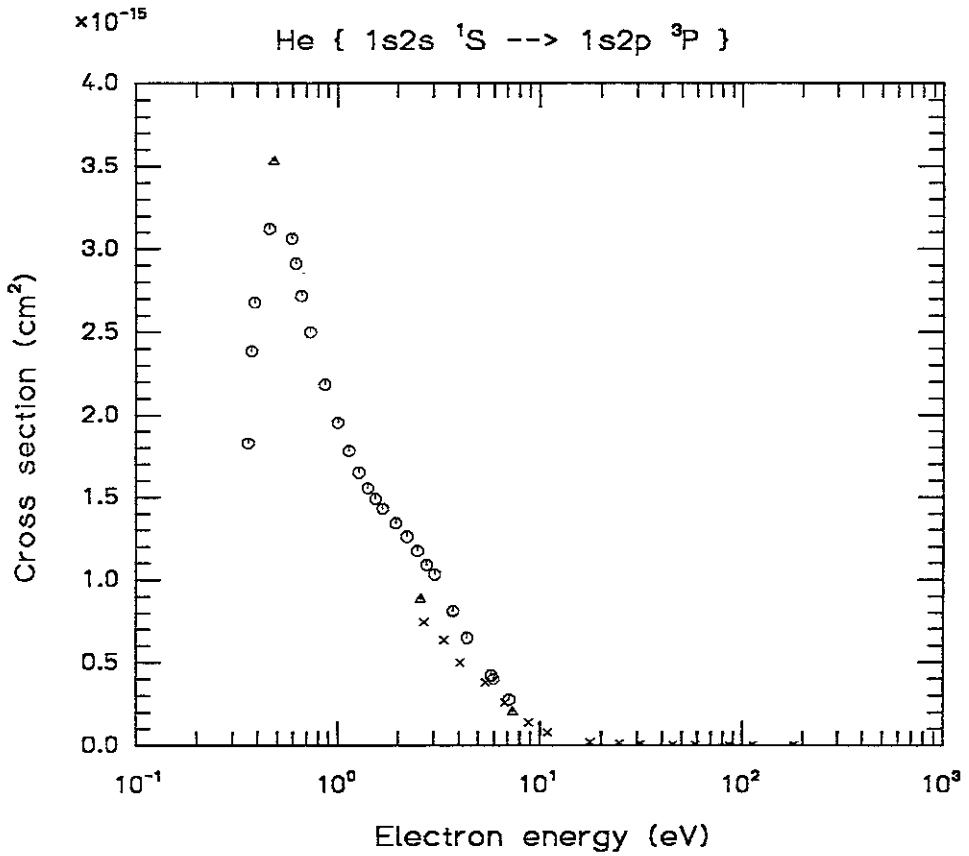


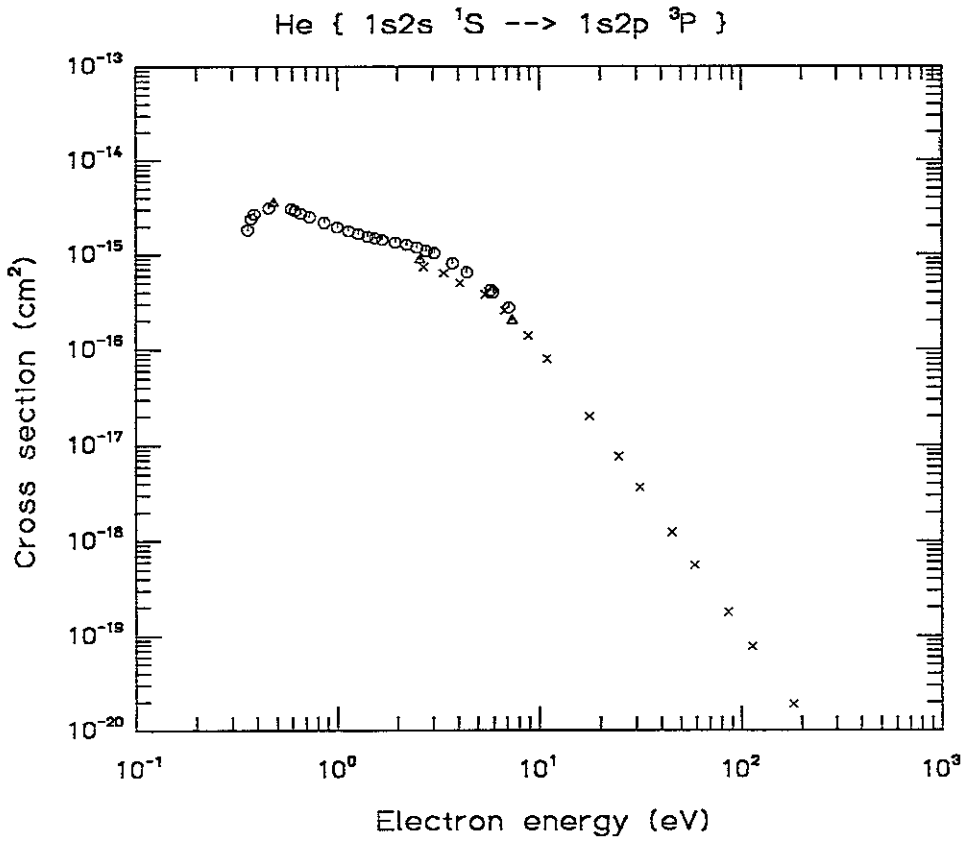

⊙ Vanderpoorten, R. (1970) T



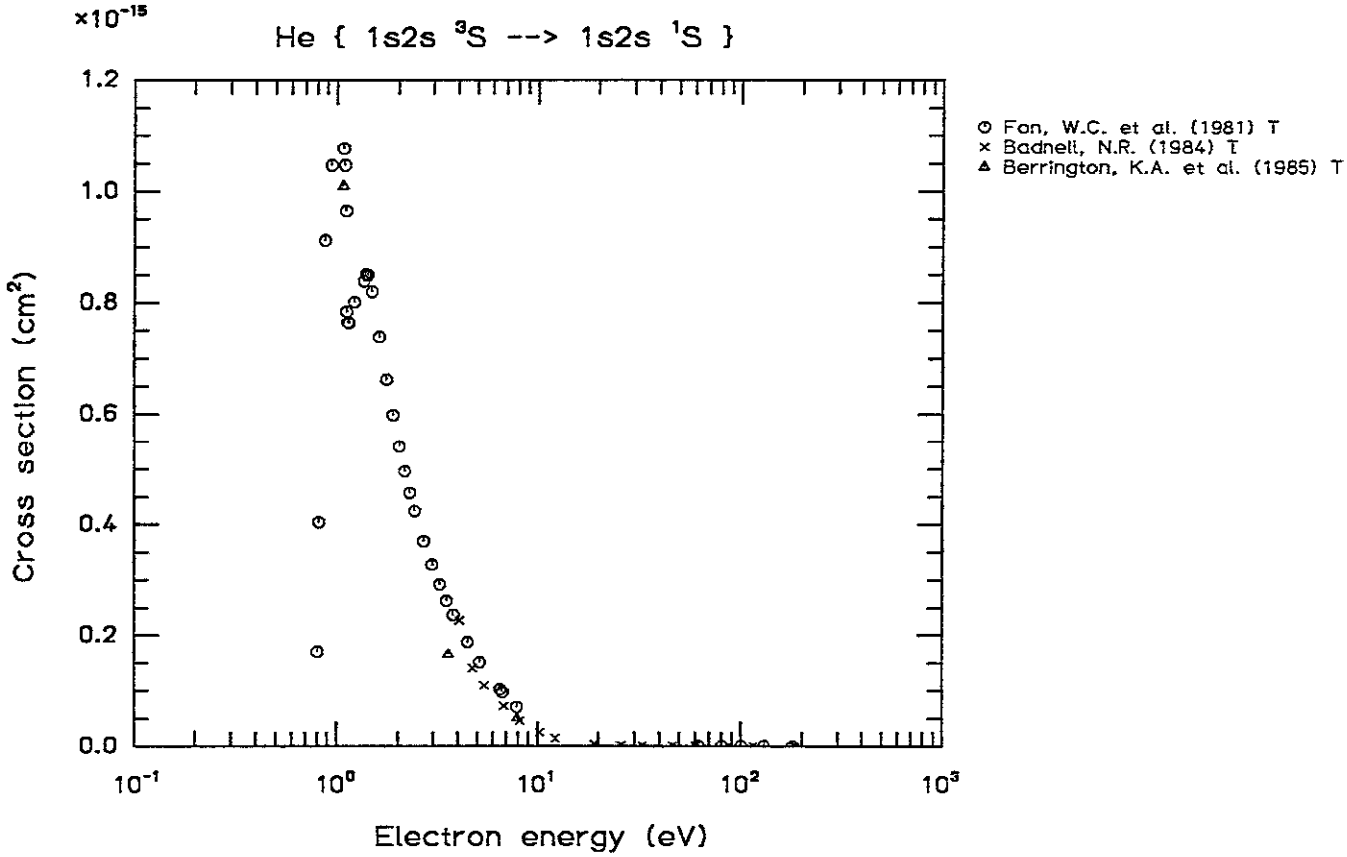

⊙ Vanderpoorten, R. (1970) T

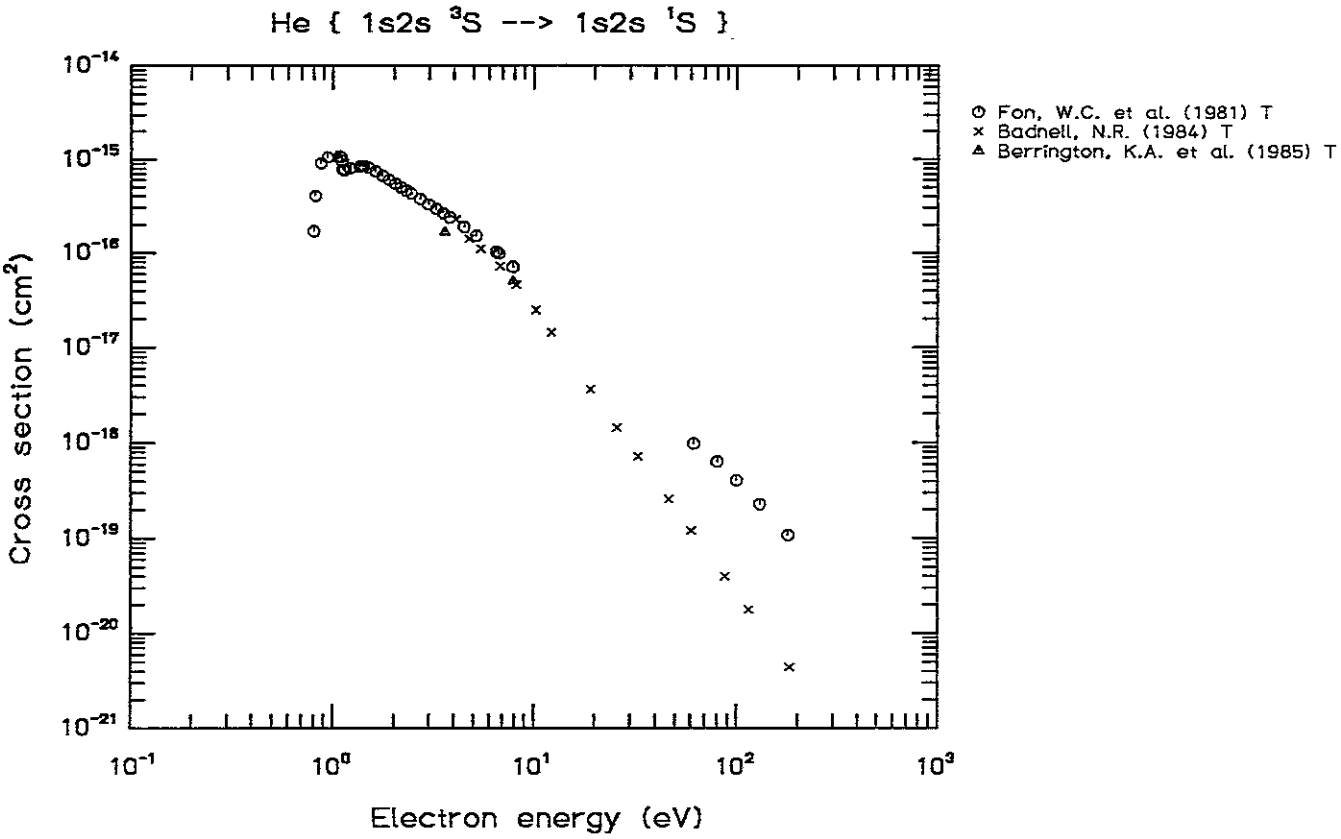


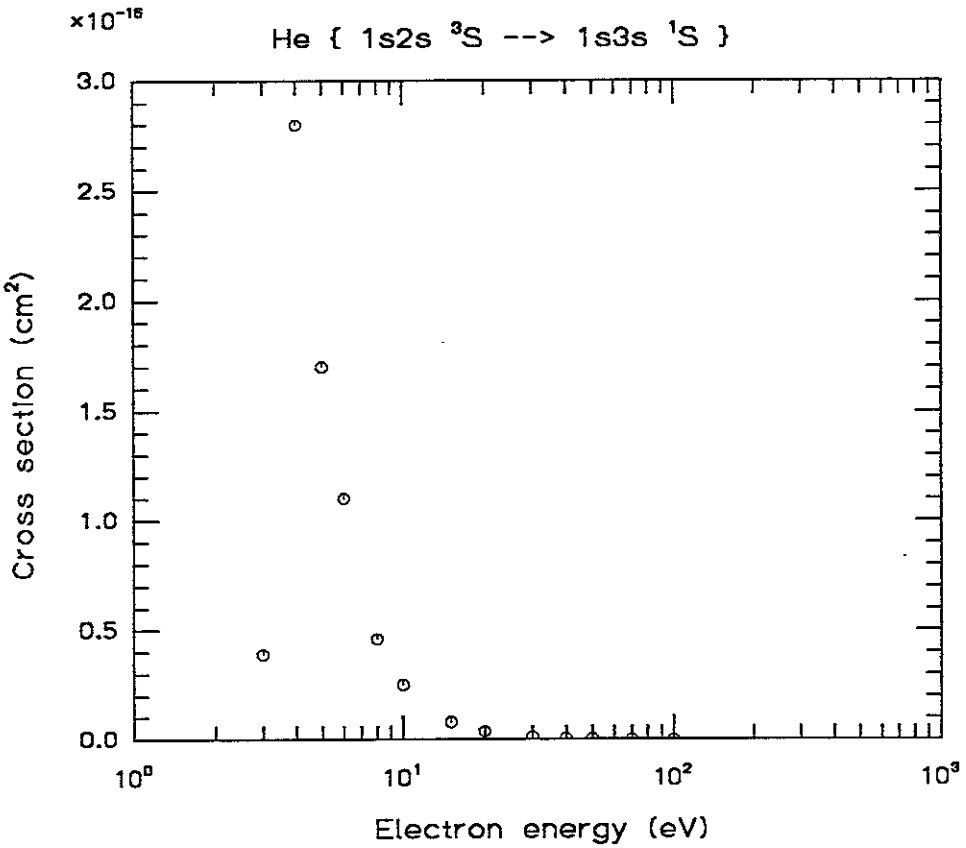

⊙ Fon, W.C. et al. (1981) T
× Badnell, N.R. (1984) T
△ Berrington, K.A. et al. (1985) T



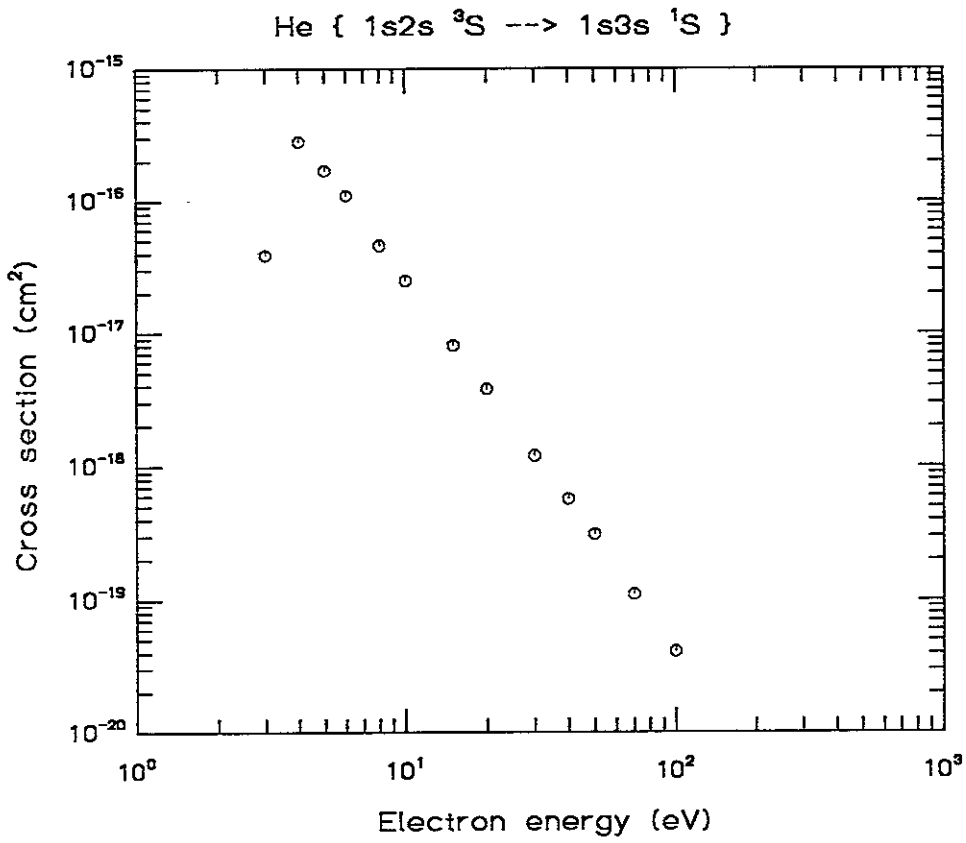

⊙ Fon, W.C. et al. (1981) T
× Badnell, N.R. (1984) T
△ Berrington, K.A. et al. (1985) T


He { 1s2s 3S --> 1s2s 1S }
×10-15
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Cross section (cm2)
10-1
100
101
102
103
Electron energy (eV)
Fon, W.C. et al. (1981) T
Badnell, N.R. (1984) T
Berrington, K.A. et al. (1985) T

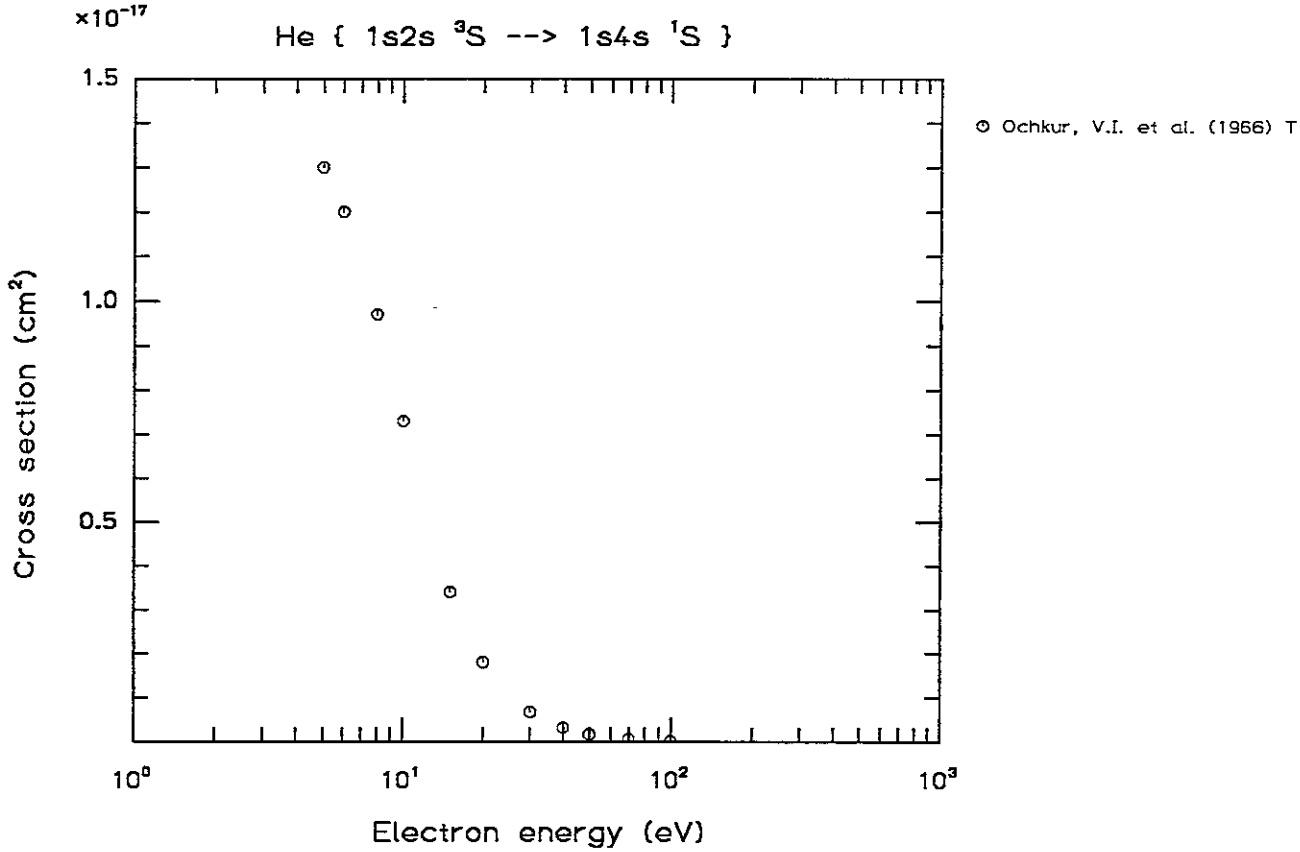

He { 1s2s 3S --> 1s2s 1S }
10-14
10-15
10-16
10-17
10-18
10-19
10-20
10-21
Cross section (cm2)
10-1
100
101
102
103
Electron energy (eV)
Fon, W.C. et al. (1981) T
Badnell, N.R. (1984) T
Berrington, K.A. et al. (1985) T

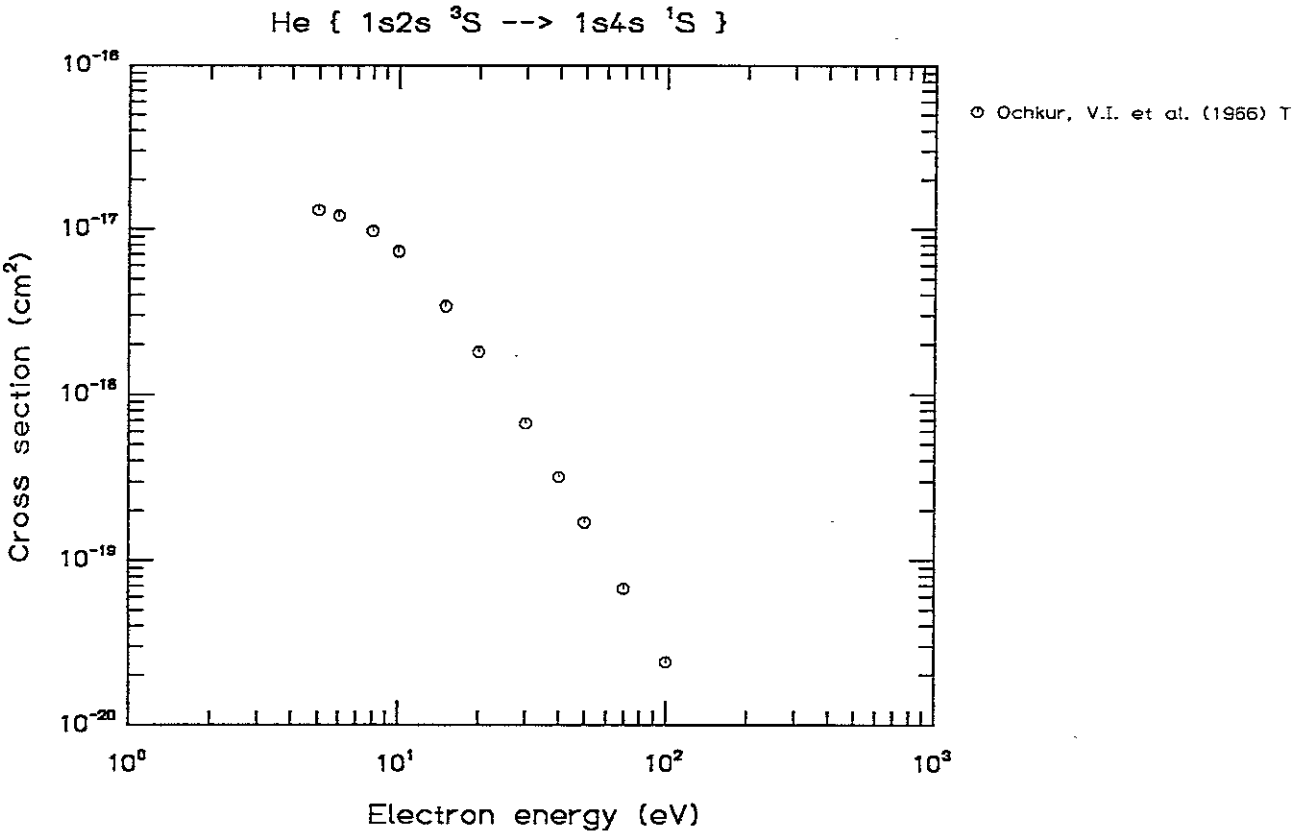


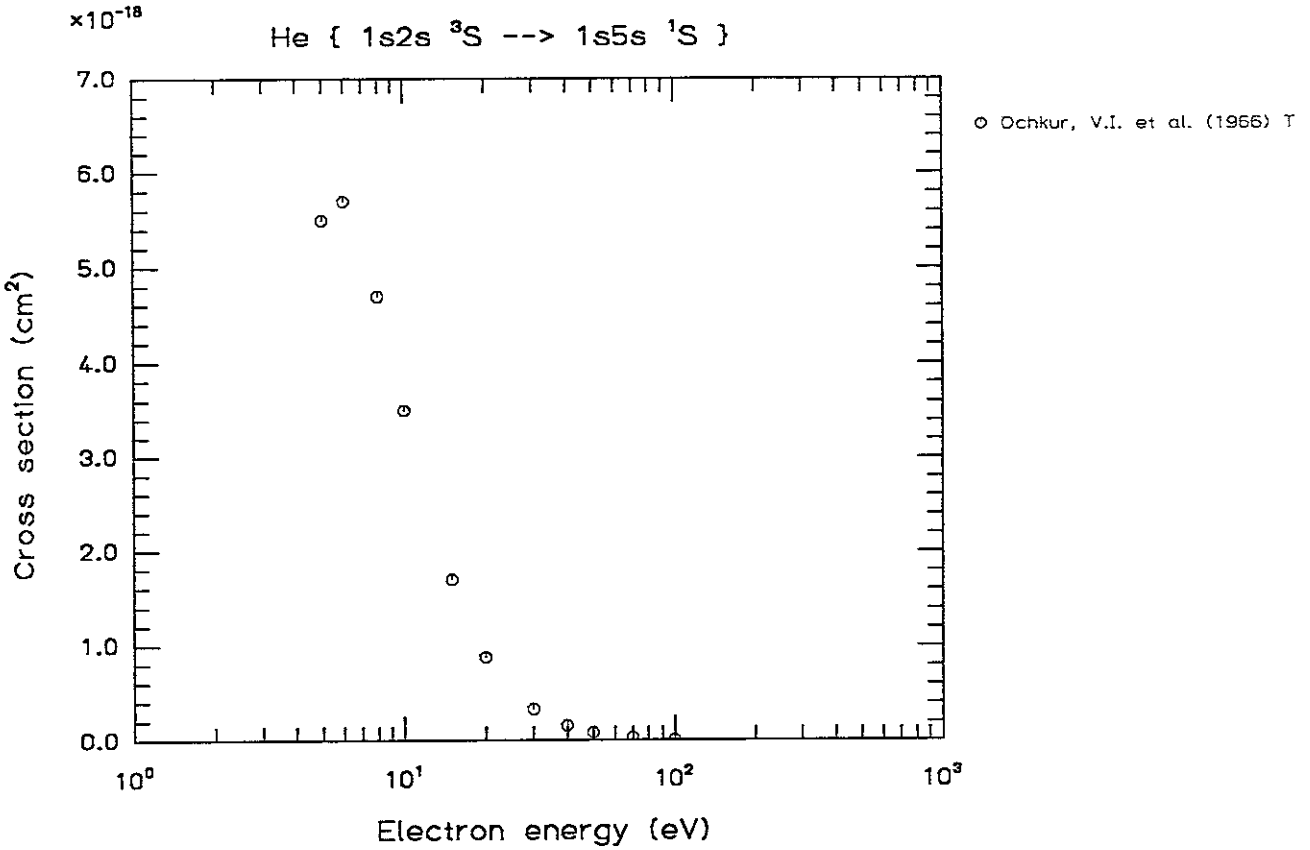

© Ochkur, V.I. et al. (1966) T

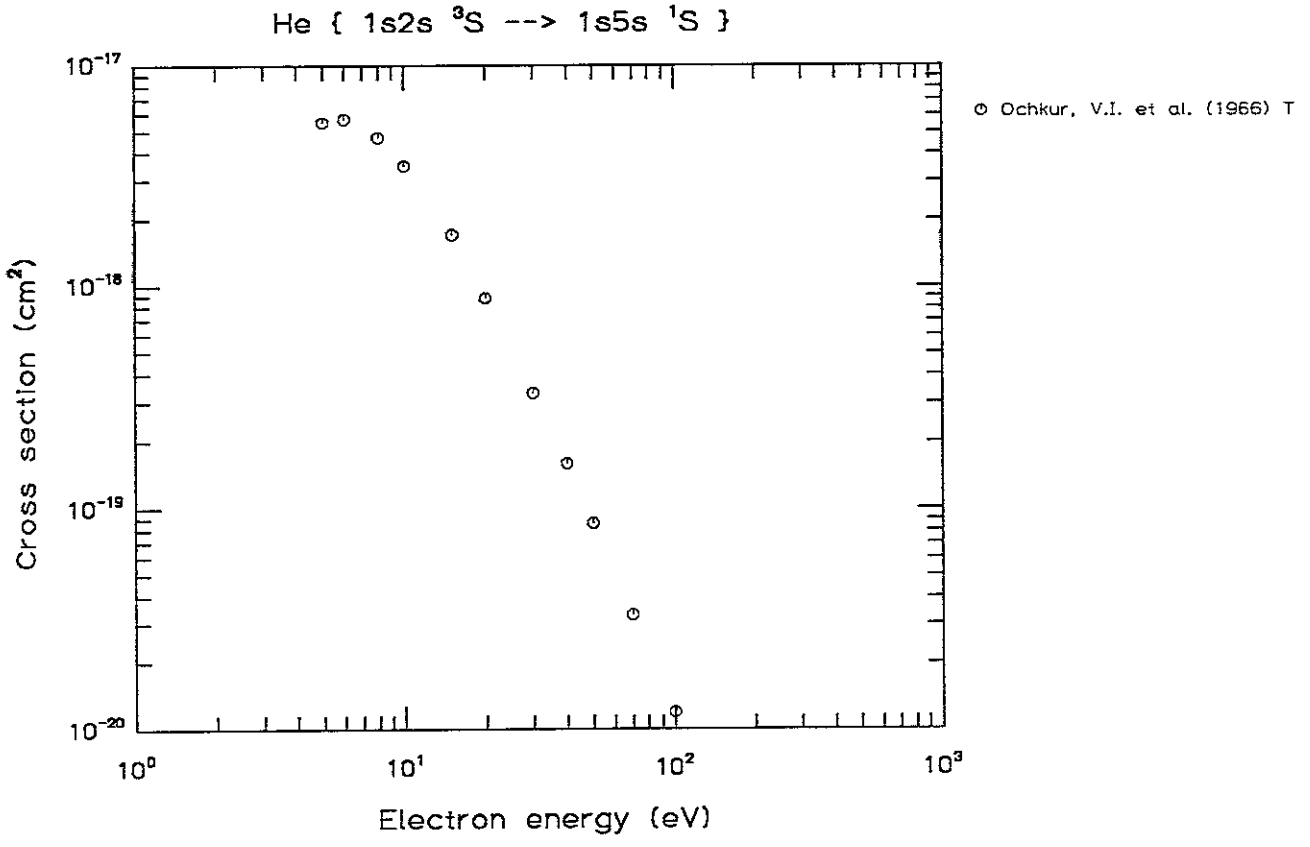


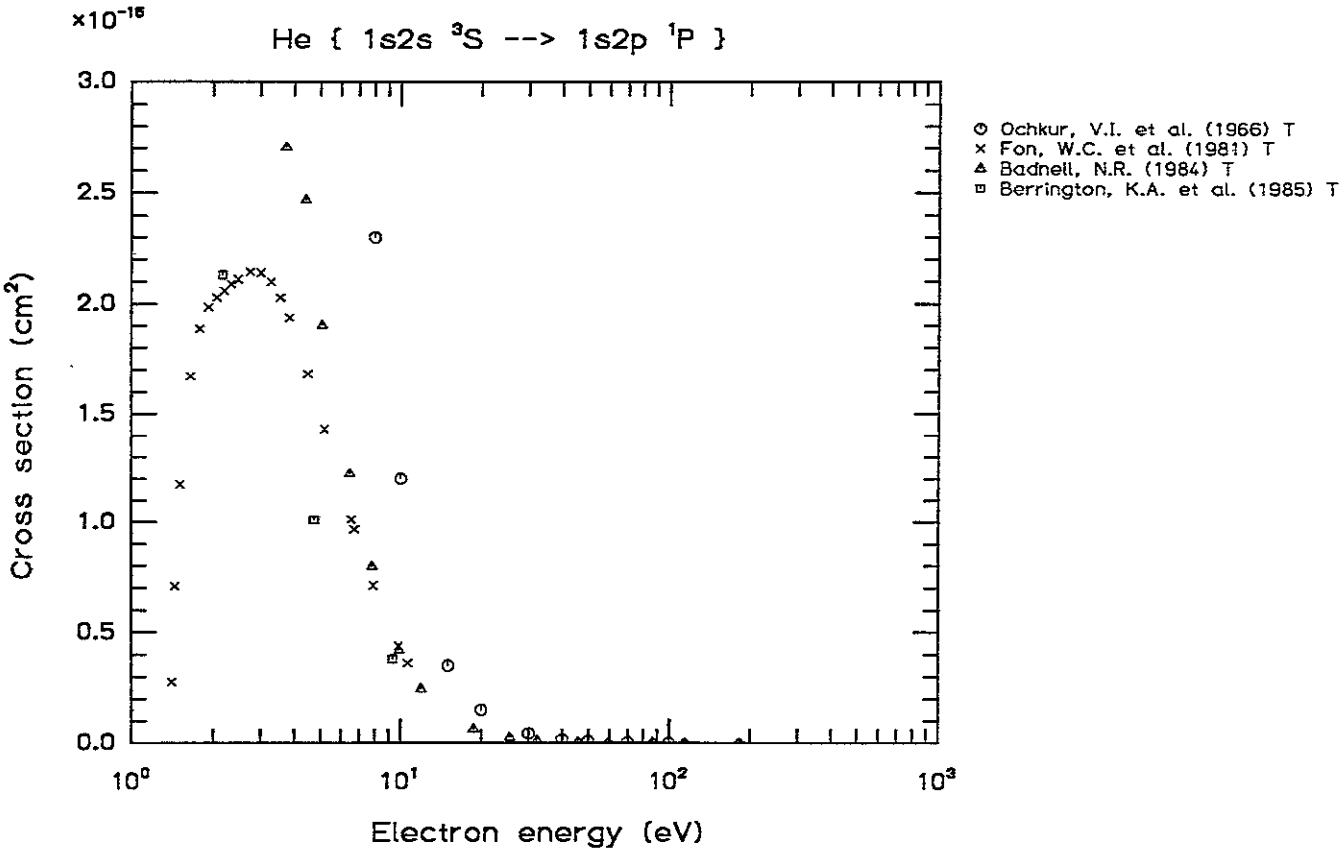

© Ochkur, V.I. et al. (1966) T

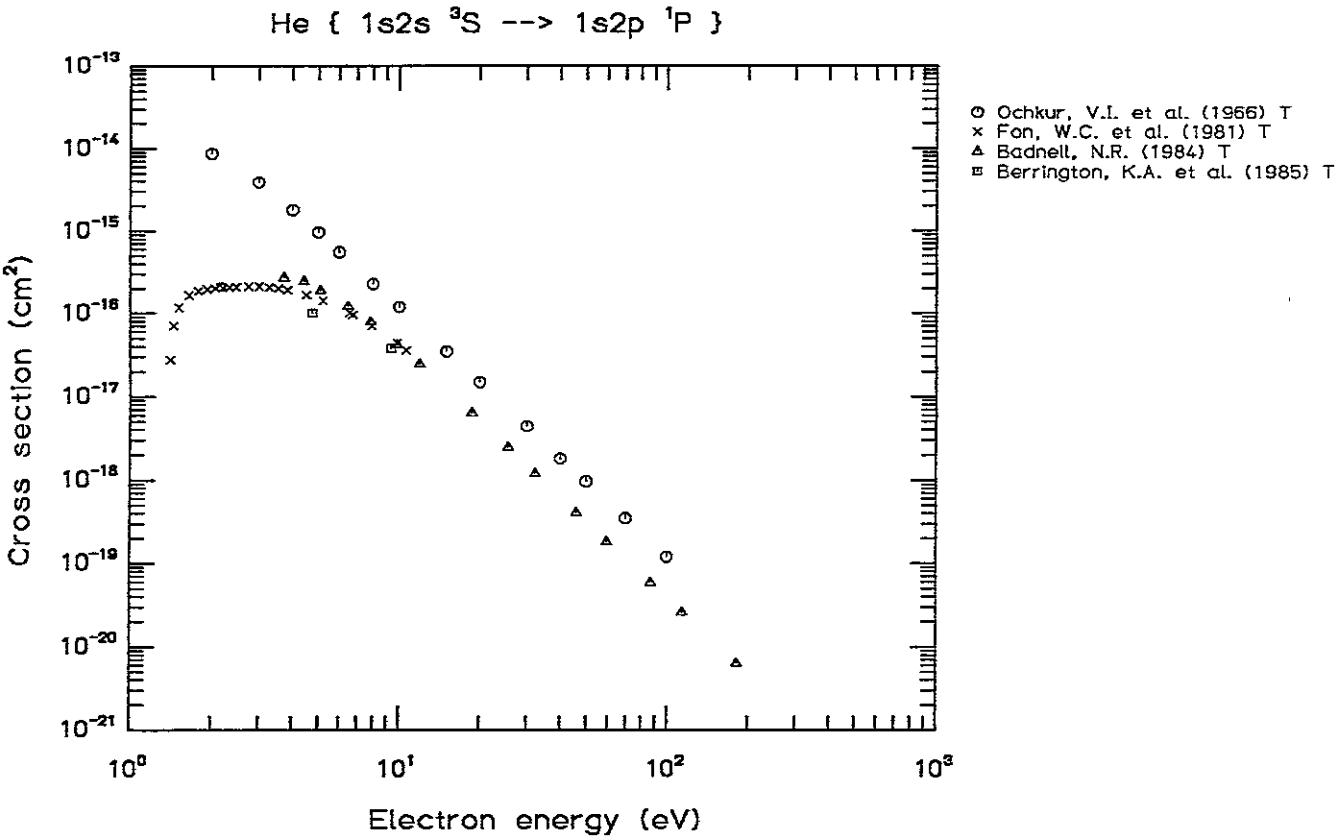

He { 1s2s ³S --> 1s4s ¹S }
×10⁻¹⁷
1.5
1.0
0.5
Cross section (cm²)
10⁰
10¹
10²
10³
Electron energy (eV)
Ochkur, V.I. et al. (1966) T

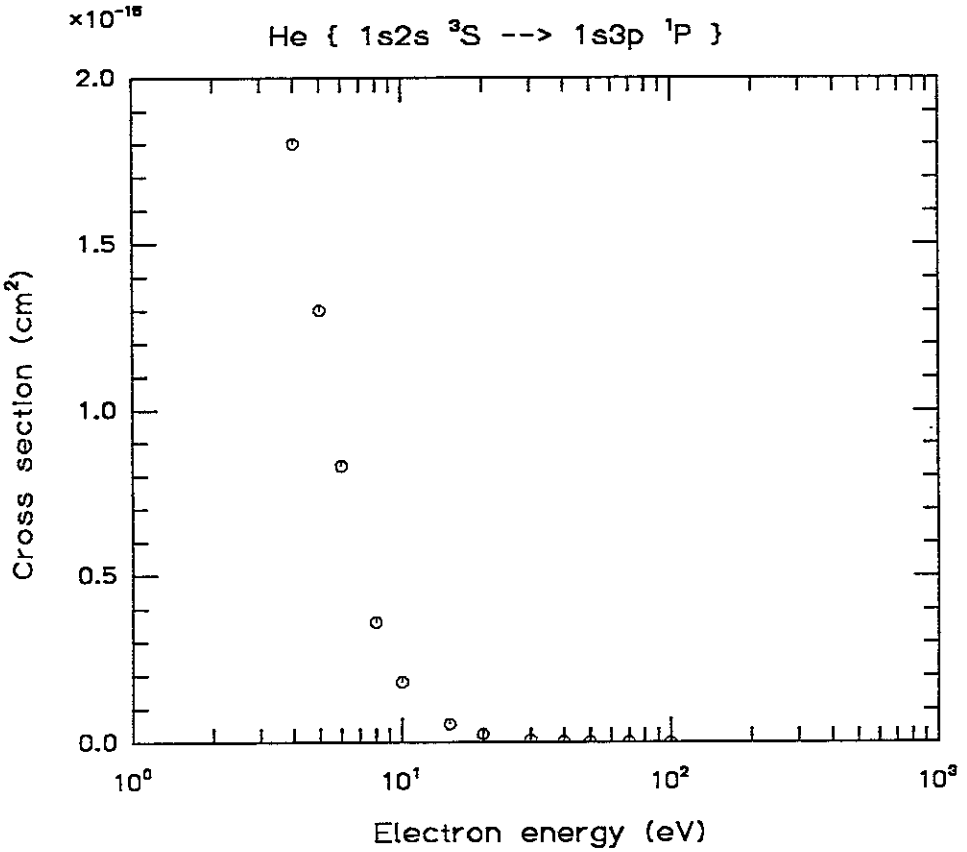

He { 1s2s ³S --> 1s4s ¹S }
10⁻¹⁶
10⁻¹⁷
10⁻¹⁸
10⁻¹⁹
10⁻²⁰
Cross section (cm²)
10⁰
10¹
10²
10³
Electron energy (eV)
Ochkur, V.I. et al. (1966) T

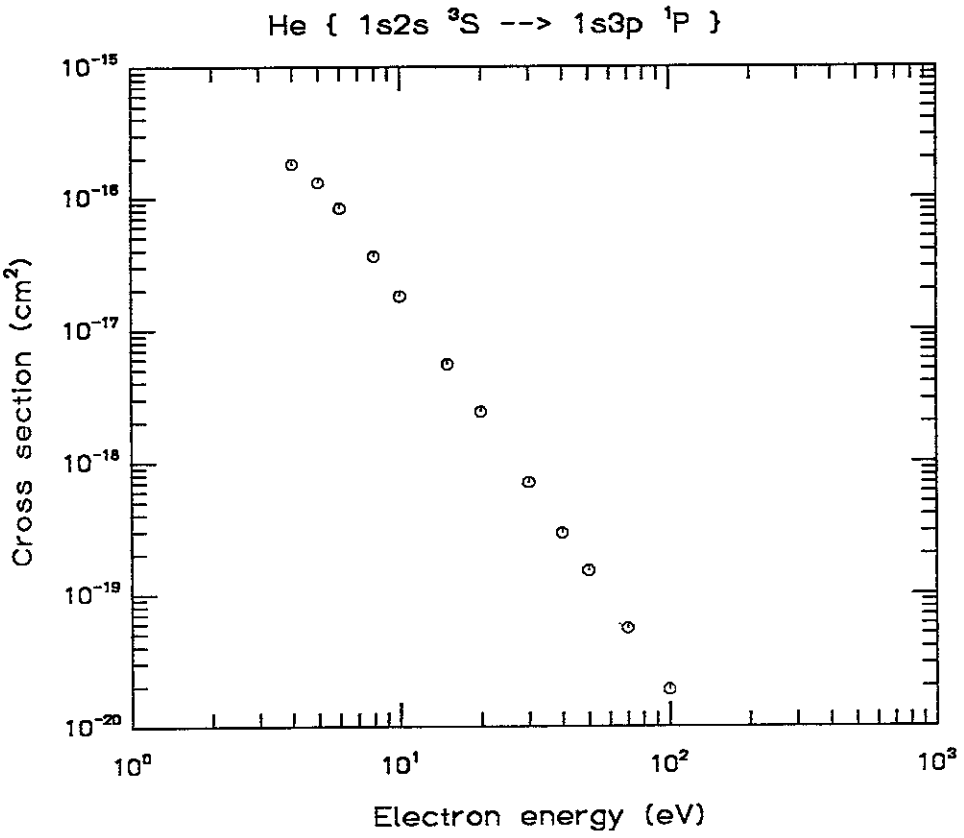

He { 1s2s 3S --> 1s5s 1S }
×10-18
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Cross section (cm2)
10^0
10^1
10^2
10^3
Electron energy (eV)
Ochkur, V.I. et al. (1966) T

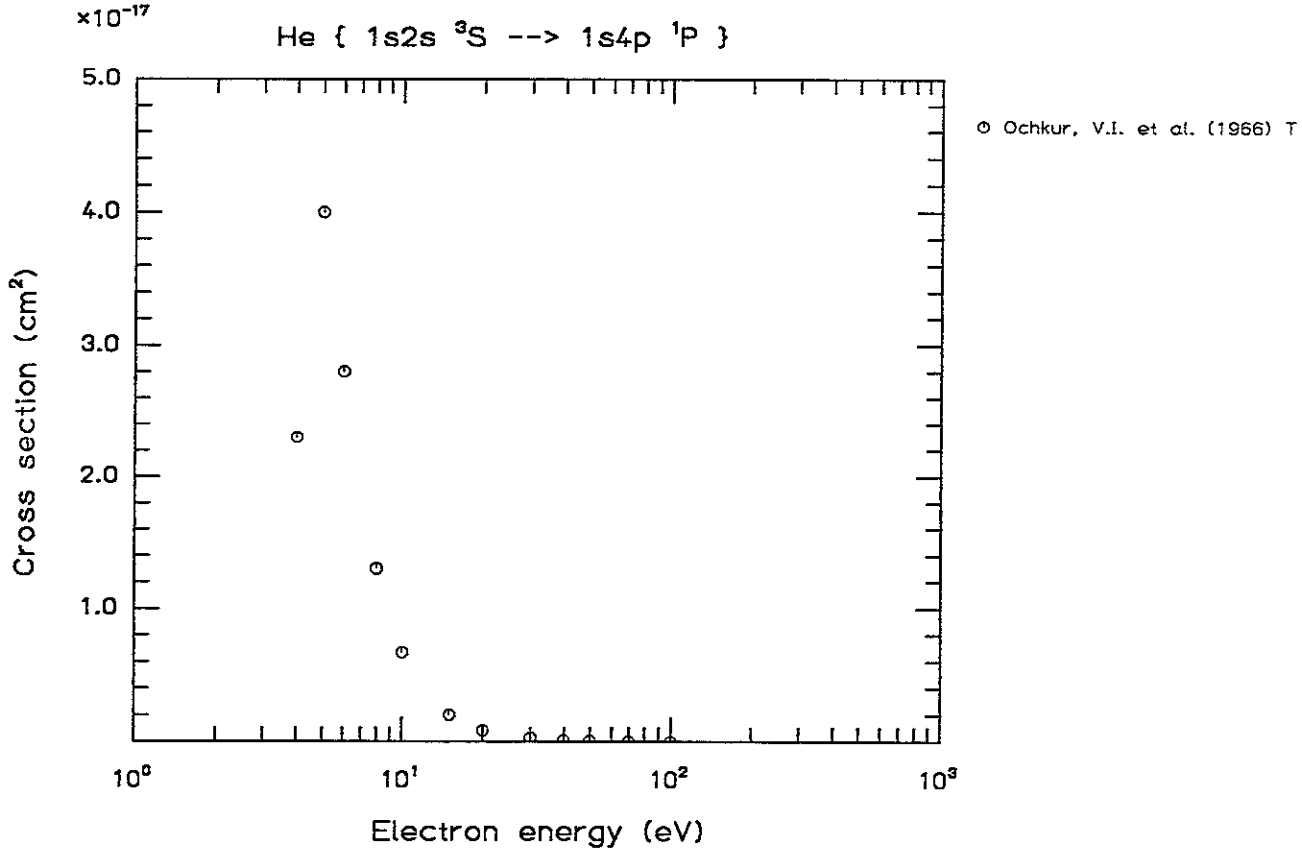

He { 1s2s 3S --> 1s5s 1S }
10-17
10-18
10-19
10-20
Cross section (cm2)
10^0
10^1
10^2
10^3
Electron energy (eV)
Ochkur, V.I. et al. (1966) T

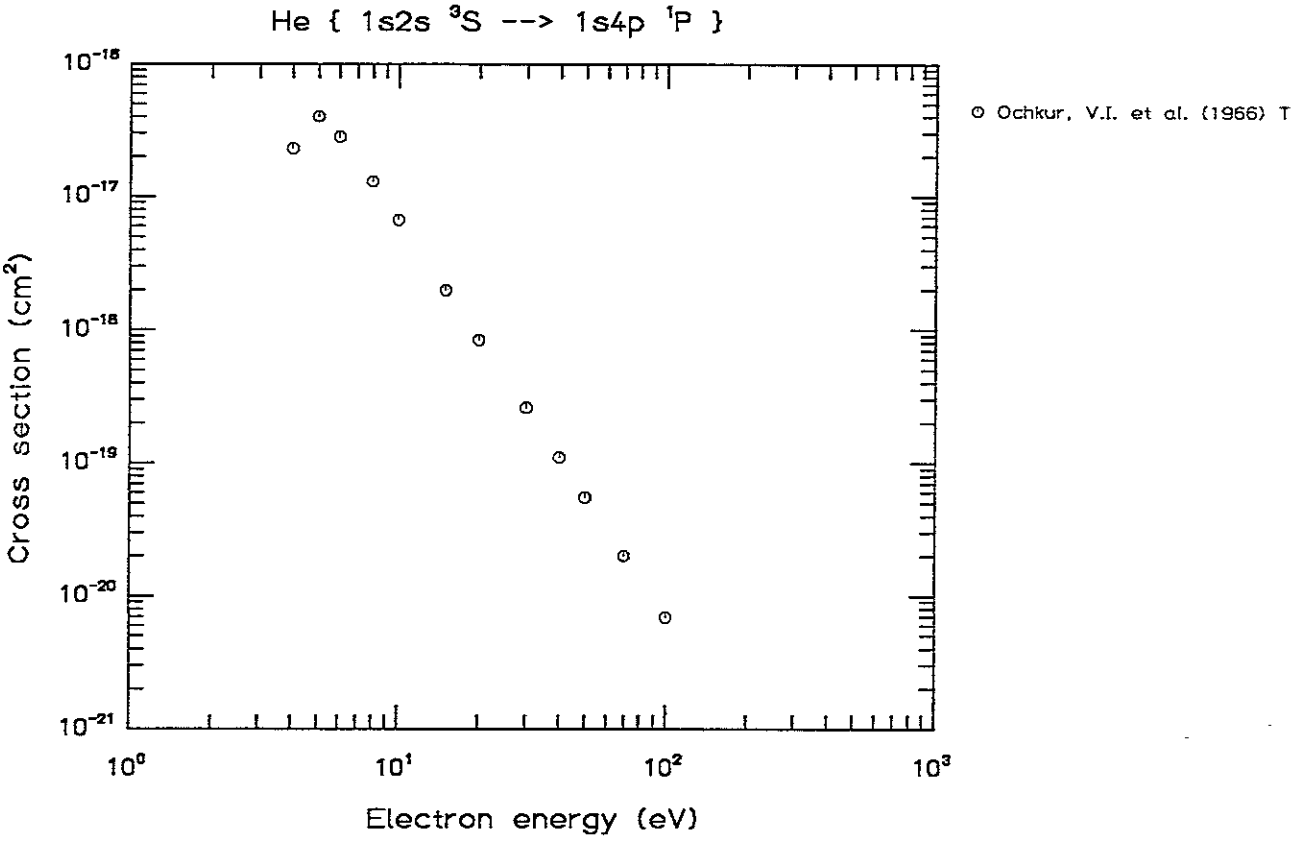

He { 1s2s 3S --> 1s2p 1P }
×10⁻¹⁵
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Cross section (cm²)
10⁰
10¹
10²
10³
Electron energy (eV)
Ochkur, V.I. et al. (1966) T
Fon, W.C. et al. (1981) T
Badnell, N.R. (1984) T
Berrington, K.A. et al. (1985) T

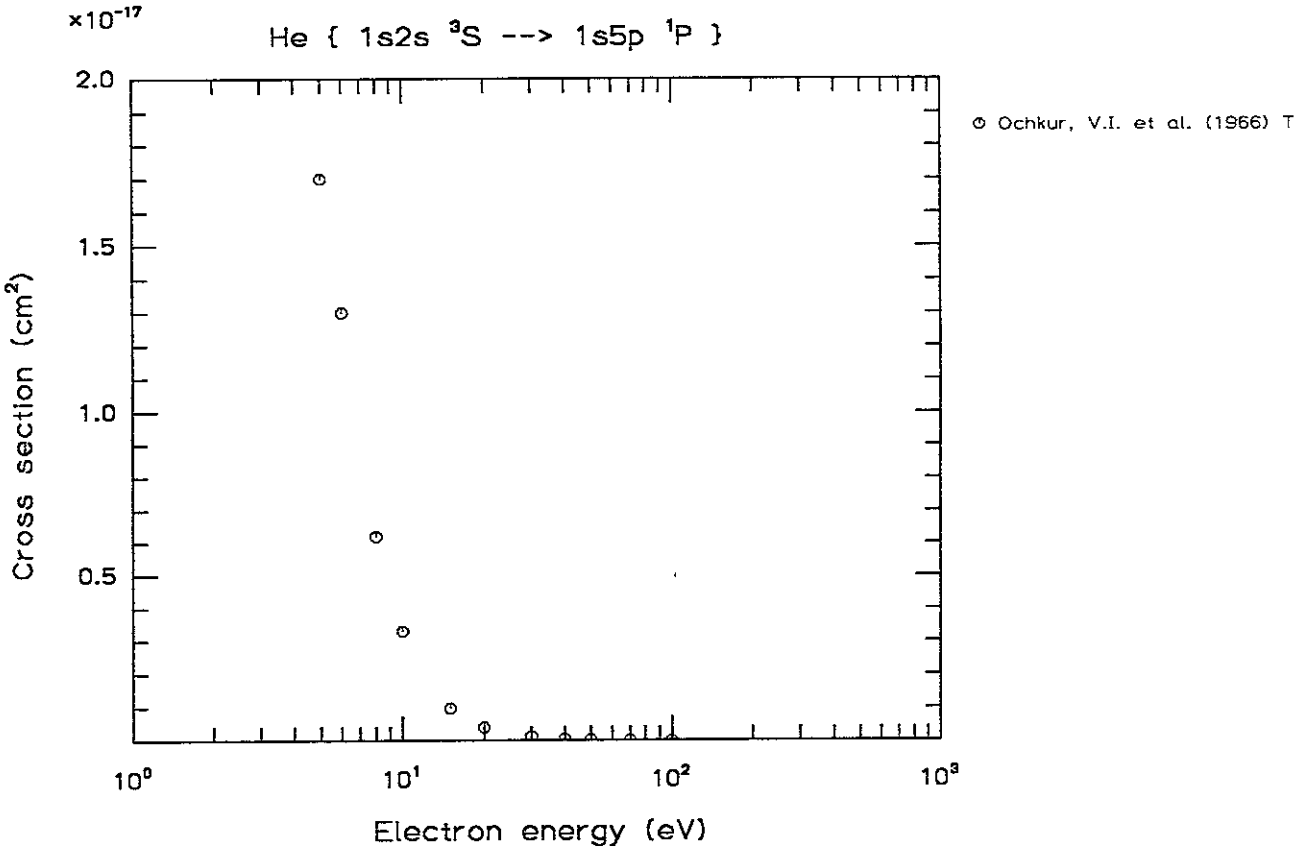

He { 1s2s 3S --> 1s2p 1P }
10⁻¹³
10⁻¹⁴
10⁻¹⁵
10⁻¹⁶
10⁻¹⁷
10⁻¹⁸
10⁻¹⁹
10⁻²⁰
10⁻²¹
Cross section (cm²)
10⁰
10¹
10²
10³
Electron energy (eV)
Ochkur, V.I. et al. (1966) T
Fon, W.C. et al. (1981) T
Badnell, N.R. (1984) T
Berrington, K.A. et al. (1985) T

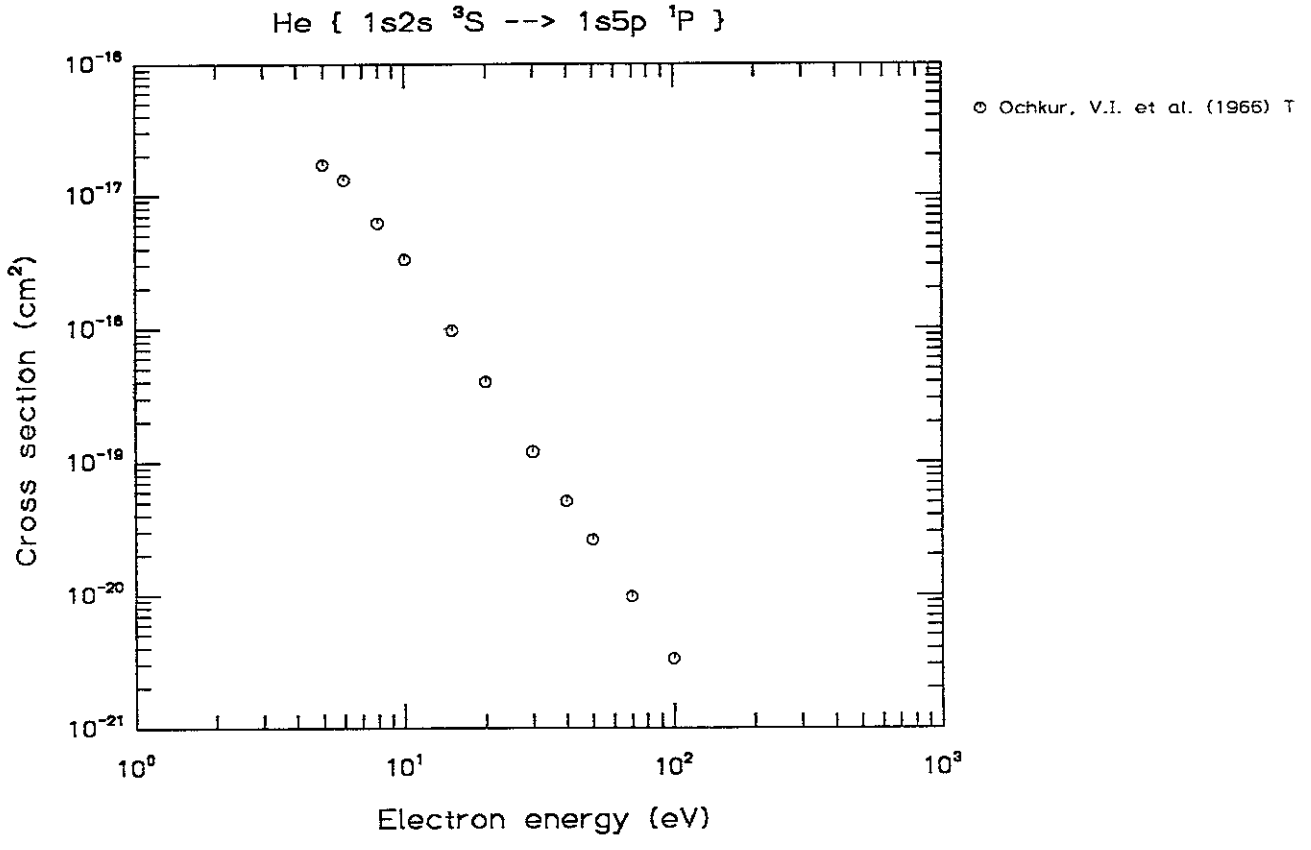

He { 1s2s 3S --> 1s3p 1P }
×10-16
2.0
1.5
1.0
0.5
0.0
Cross section (cm2)
10^0
10^1
10^2
10^3
Electron energy (eV)
Ochkur, V.I. et al. (1966) T

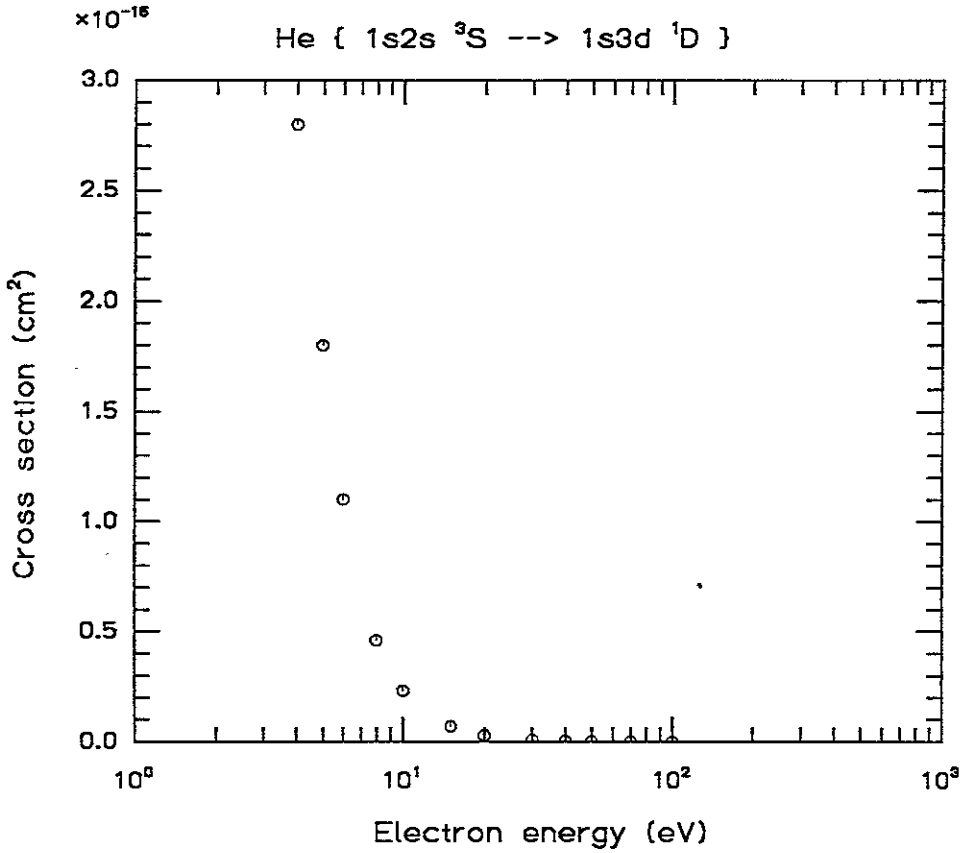

He { 1s2s 3S --> 1s3p 1P }
10-15
10-16
10-17
10-18
10-19
10-20
Cross section (cm2)
10^0
10^1
10^2
10^3
Electron energy (eV)
Ochkur, V.I. et al. (1966) T

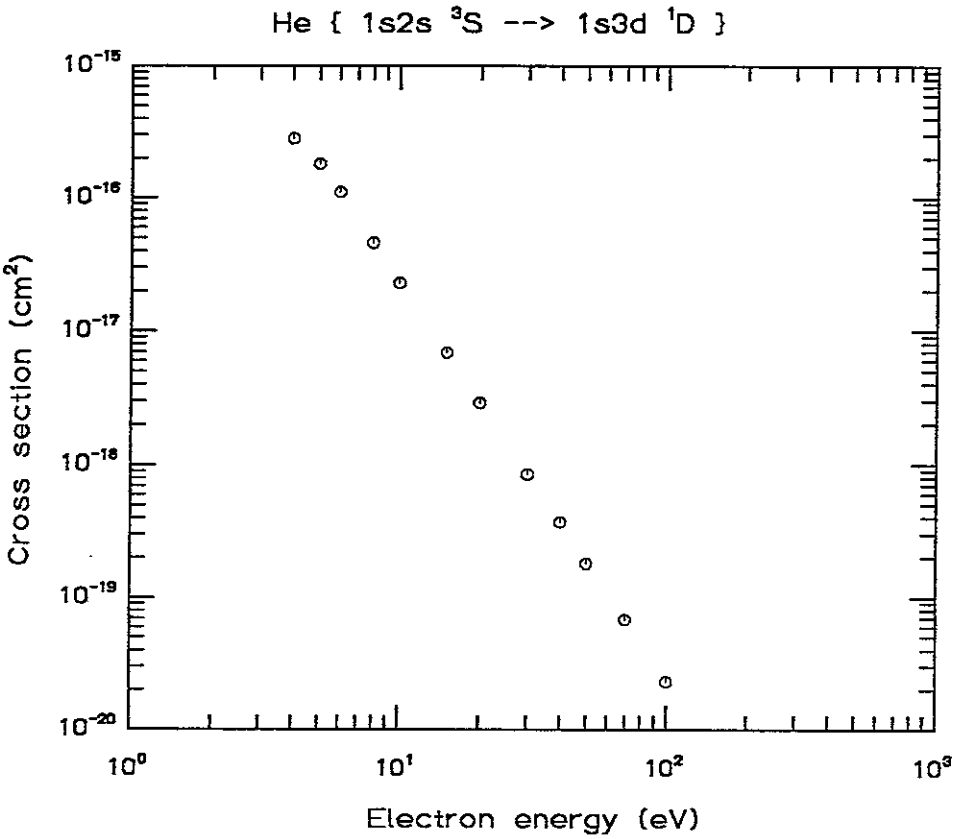

He { 1s2s 3S --> 1s4p 1P }
×10-17
5.0
4.0
3.0
2.0
1.0
Cross section (cm2)
10^0
10^1
10^2
10^3
Electron energy (eV)
Ochkur, V.I. et al. (1966) T

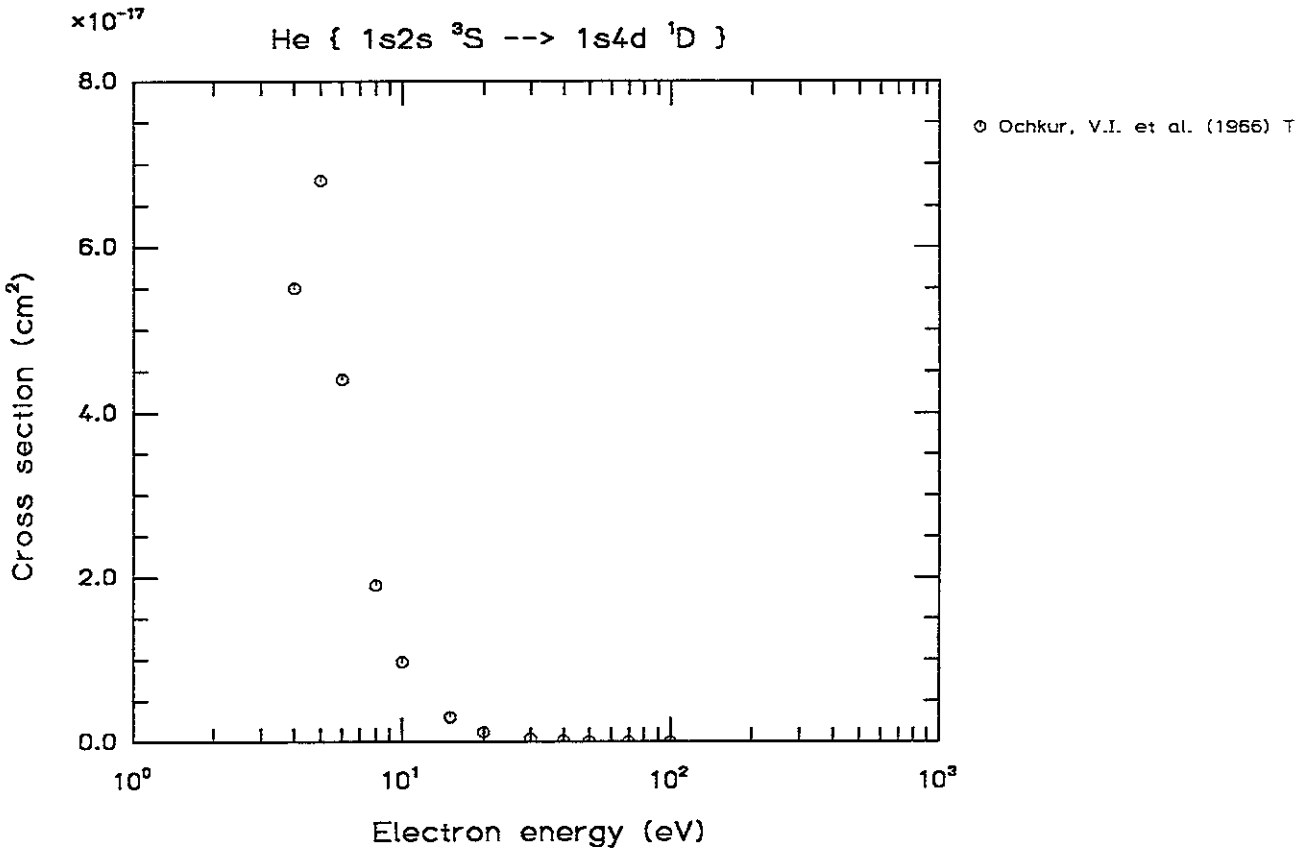

He { 1s2s 3S --> 1s4p 1P }
10-16
10-17
10-18
10-19
10-20
10-21
Cross section (cm2)
10^0
10^1
10^2
10^3
Electron energy (eV)
Ochkur, V.I. et al. (1966) T

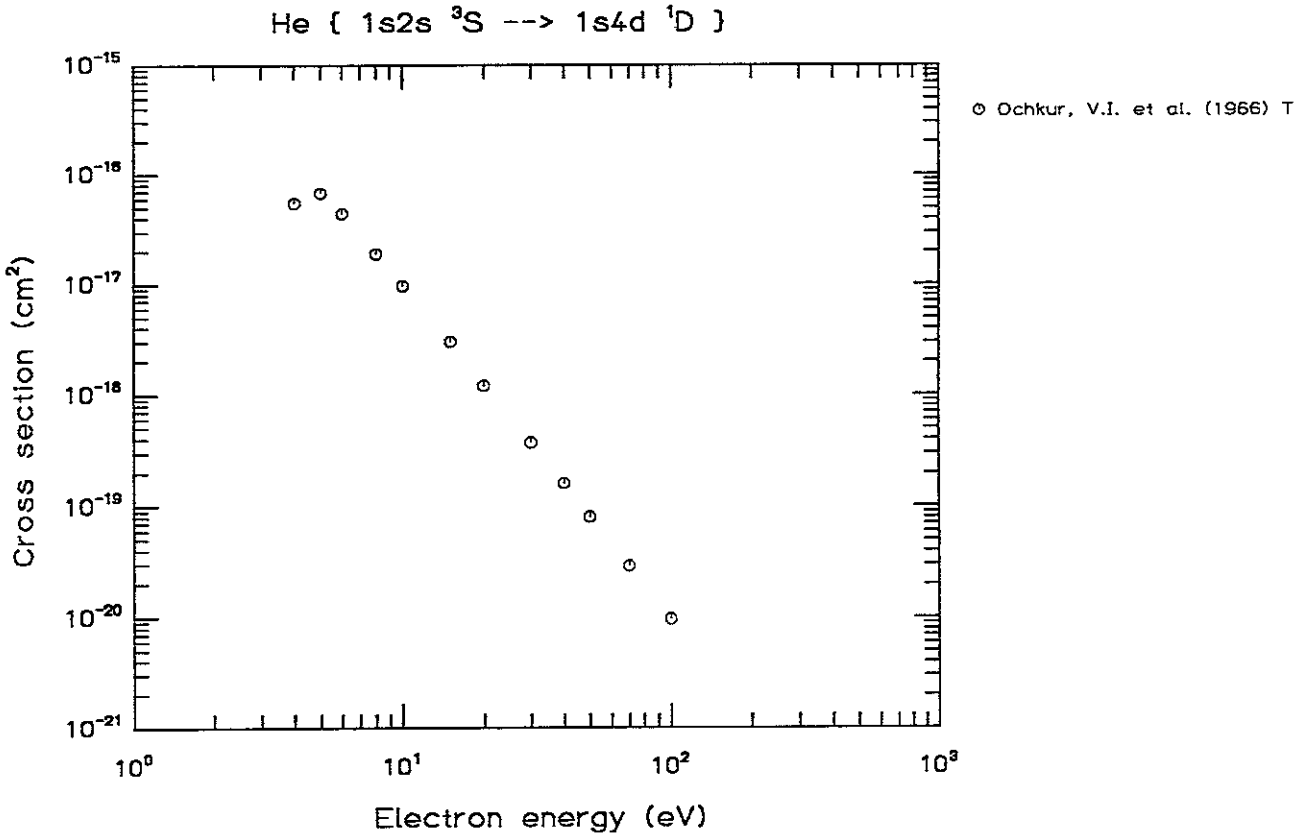

He { 1s2s 3S --> 1s5p 1P }
×10-17
2.0
1.5
1.0
0.5
Cross section (cm2)
10^0
10^1
10^2
10^3
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T

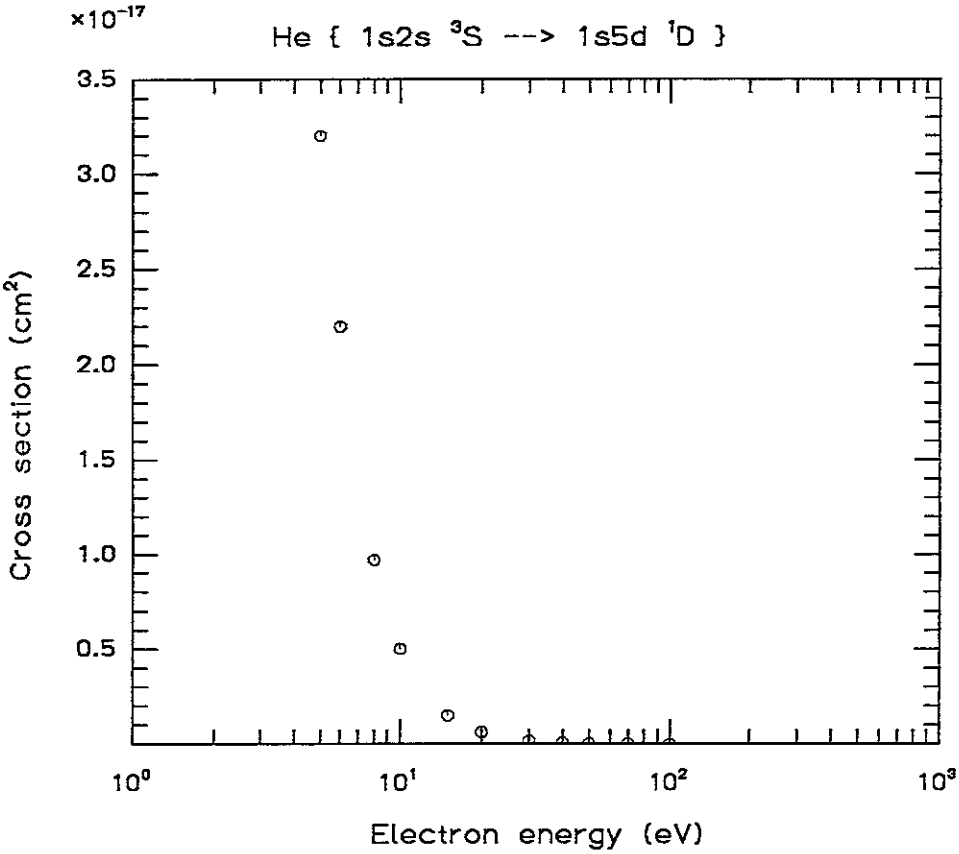

He { 1s2s 3S --> 1s5p 1P }
10-16
10-17
10-18
10-19
10-20
10-21
Cross section (cm2)
10^0
10^1
10^2
10^3
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T


He { 1s2s 3S --> 1s3d 1D }
×10⁻¹⁵
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Cross section (cm²)
10⁰
10¹
10²
10³
Electron energy (eV)
Ochkur, V.I. et al. (1966) T

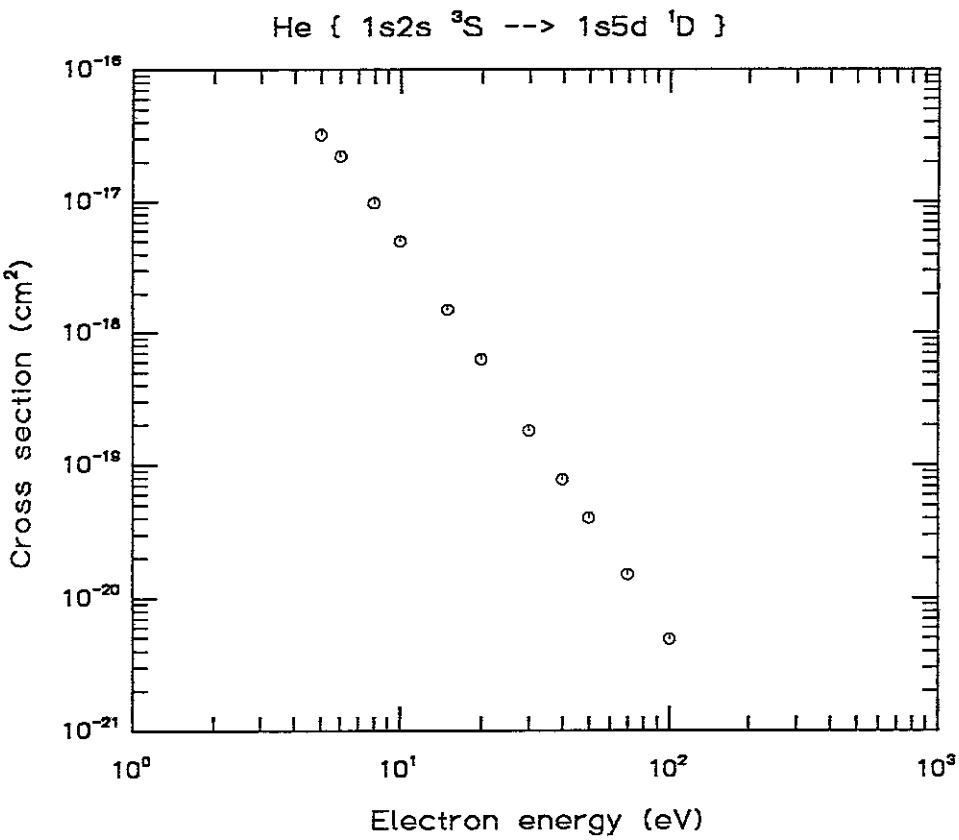

He { 1s2s 3S --> 1s3d 1D }
10⁻¹⁵
10⁻¹⁶
10⁻¹⁷
10⁻¹⁸
10⁻¹⁹
10⁻²⁰
Cross section (cm²)
10⁰
10¹
10²
10³
Electron energy (eV)
Ochkur, V.I. et al. (1966) T


He { 1s2s 3S --> 1s4d 1D }
×10-17
8.0
6.0
4.0
2.0
0.0
Cross section (cm2)
10^0
10^1
10^2
10^3
Electron energy (eV)
Ochkur, V.I. et al. (1966) T

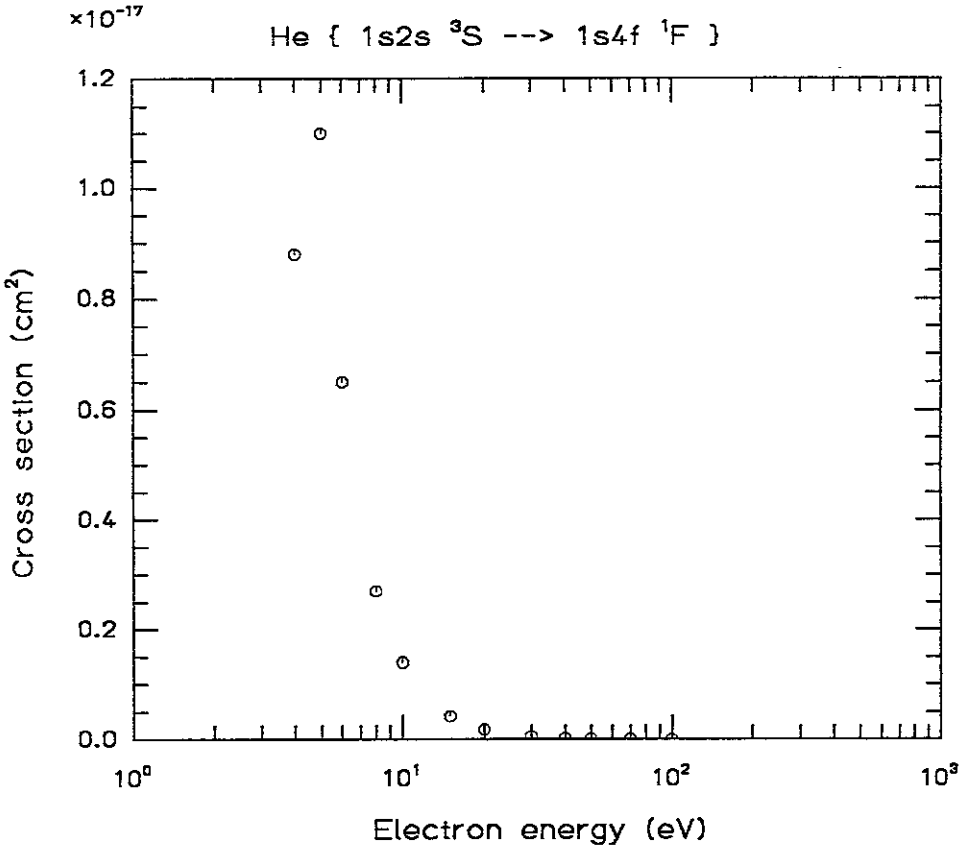

He { 1s2s 3S --> 1s4d 1D }
10-15
10-16
10-17
10-18
10-19
10-20
10-21
Cross section (cm2)
10^0
10^1
10^2
10^3
Electron energy (eV)
Ochkur, V.I. et al. (1966) T

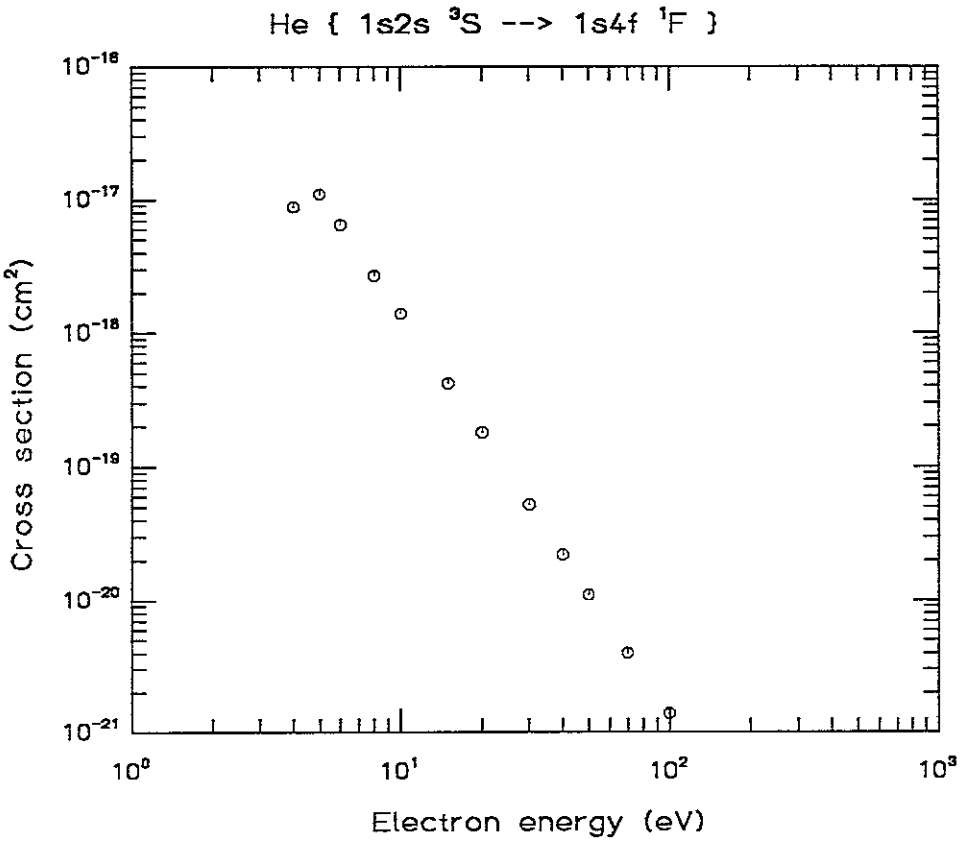


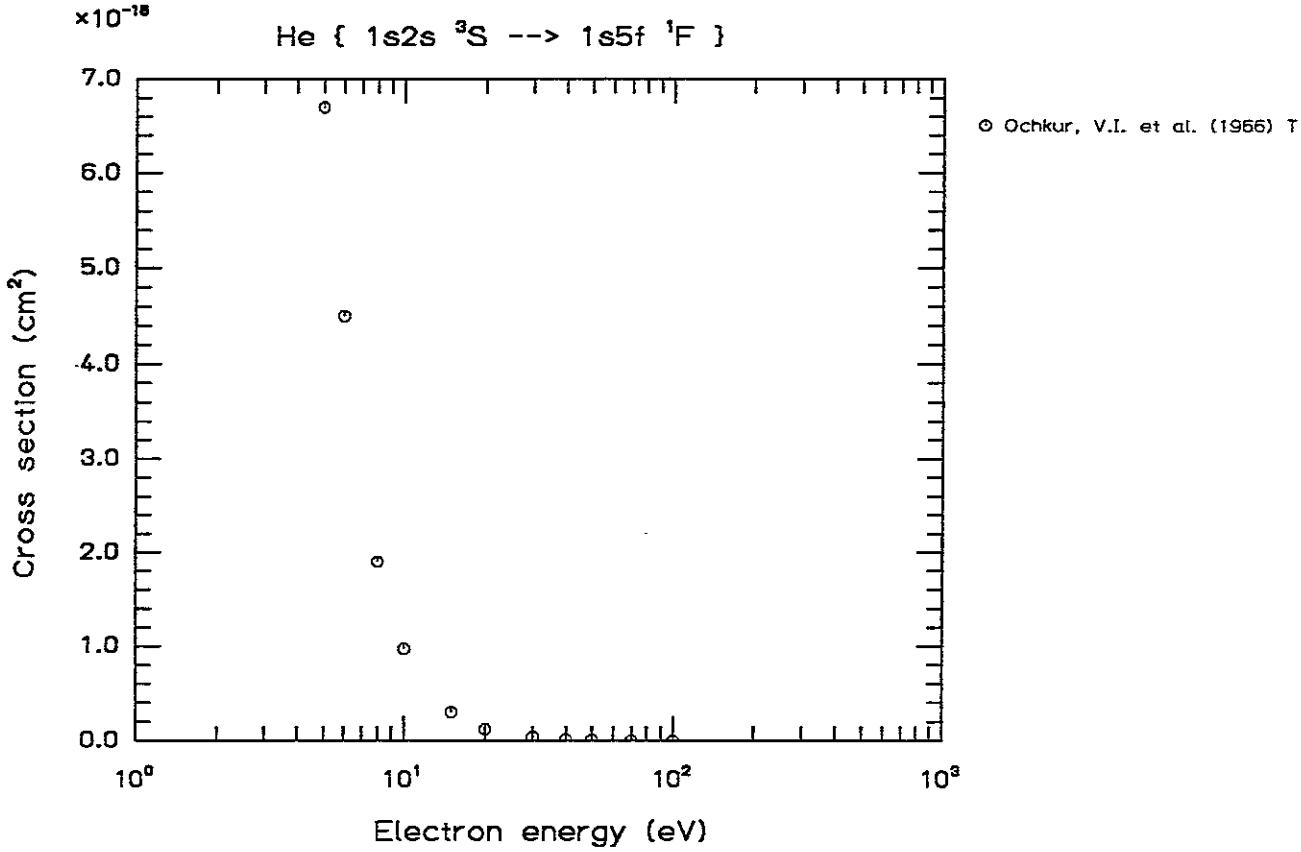

⊙ Ochkur, V.I. et al. (1966) T

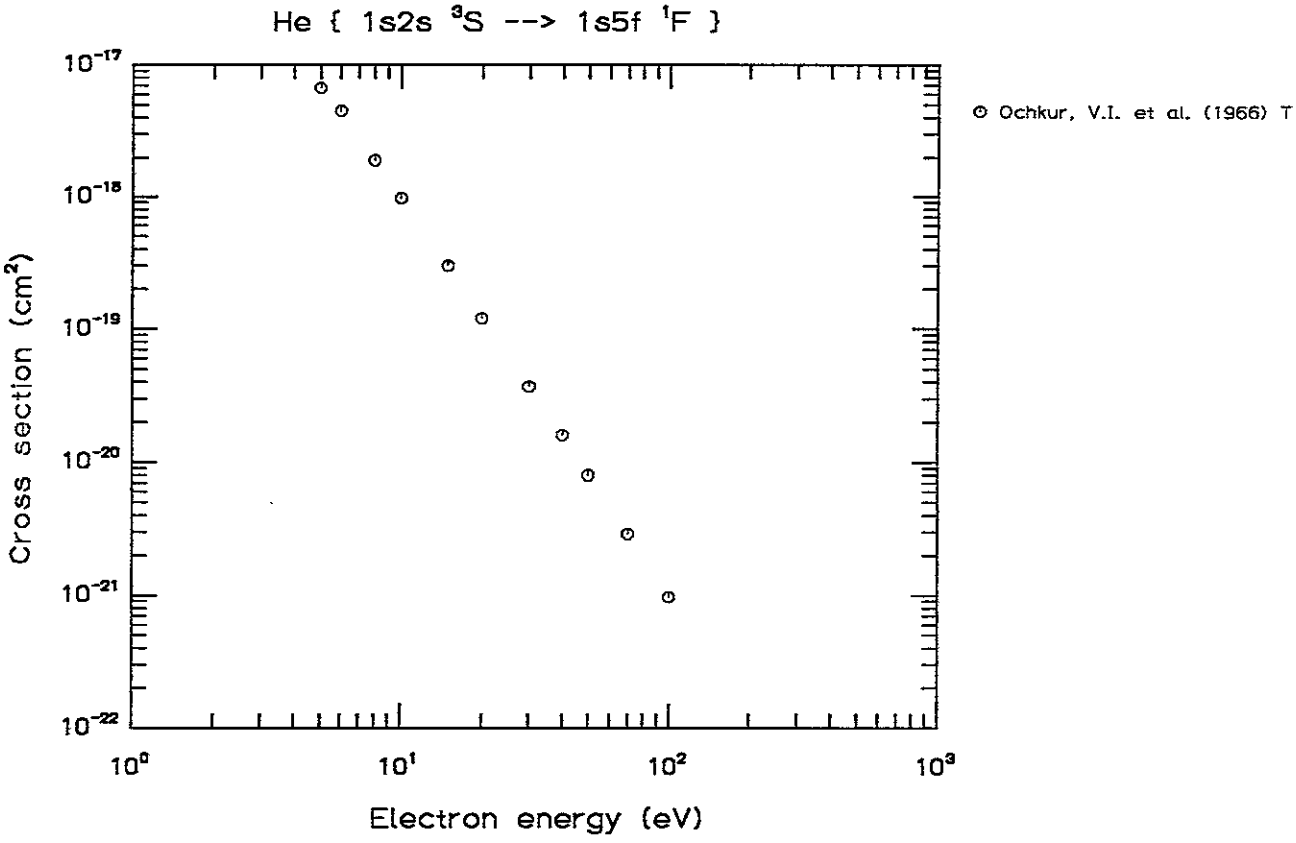


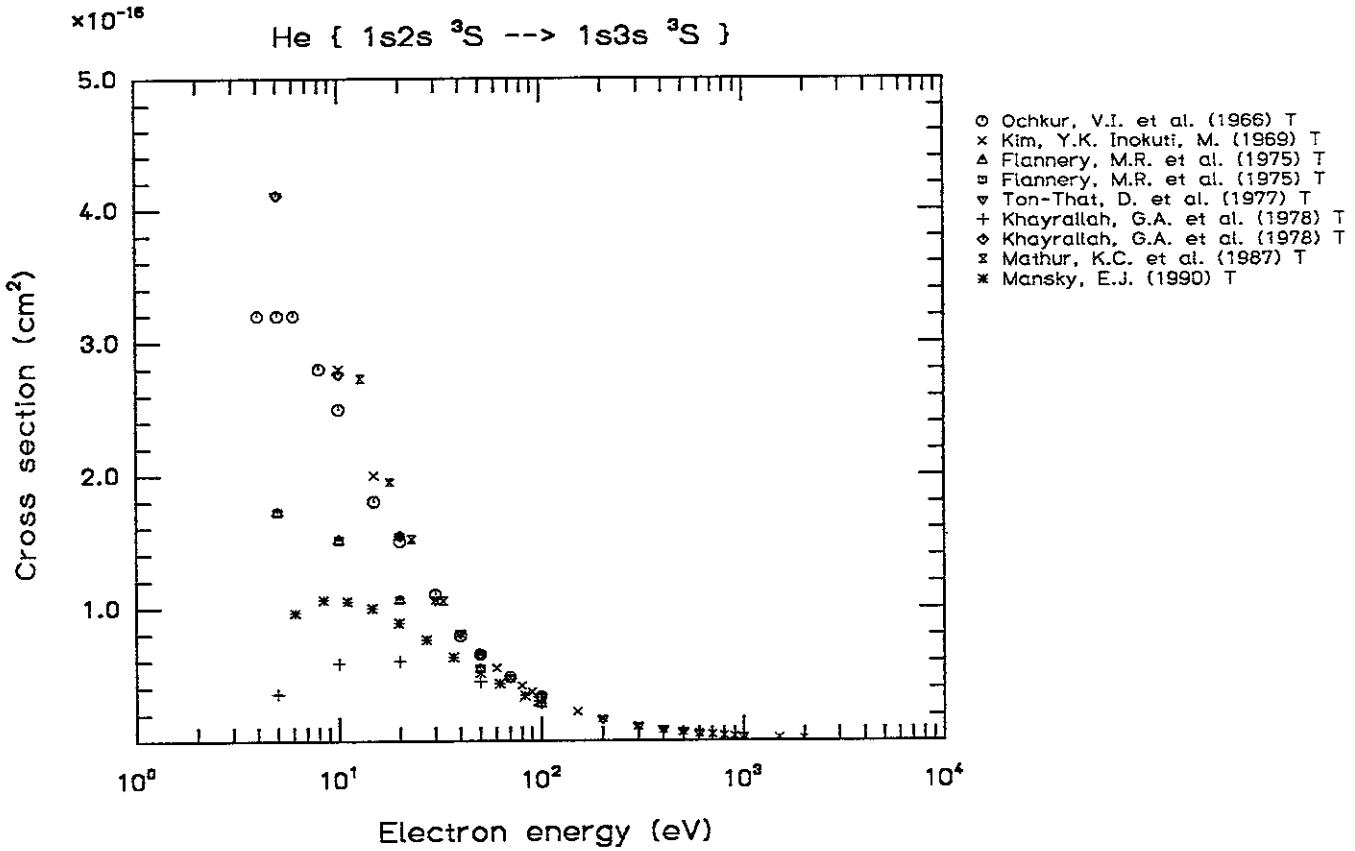

⊙ Ochkur, V.I. et al. (1966) T

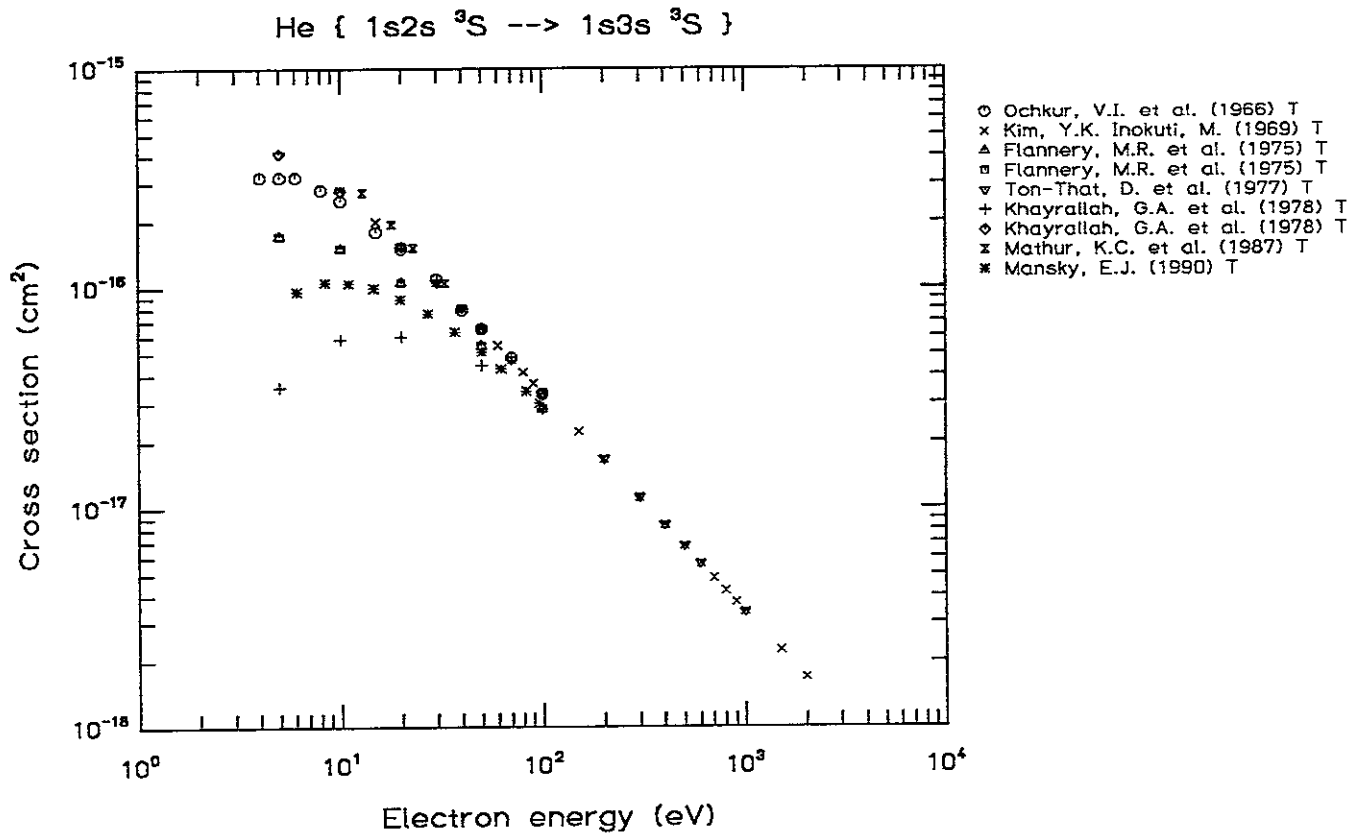

He { 1s2s 3S --> 1s4f 1F }
×10-17
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Cross section (cm2)
10^0
10^1
10^2
10^3
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T

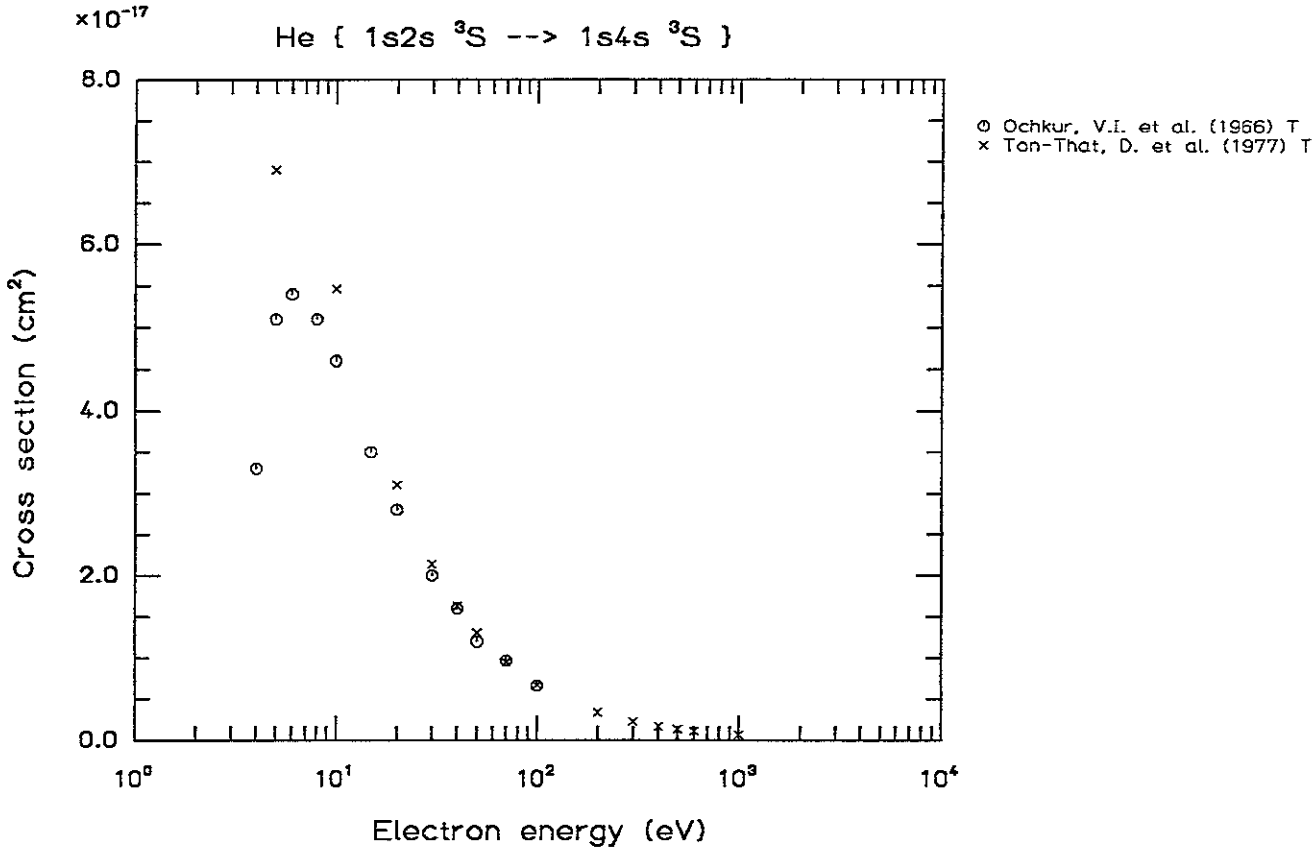

He { 1s2s 3S --> 1s4f 1F }
10-16
10-17
10-18
10-19
10-20
10-21
Cross section (cm2)
10^0
10^1
10^2
10^3
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T

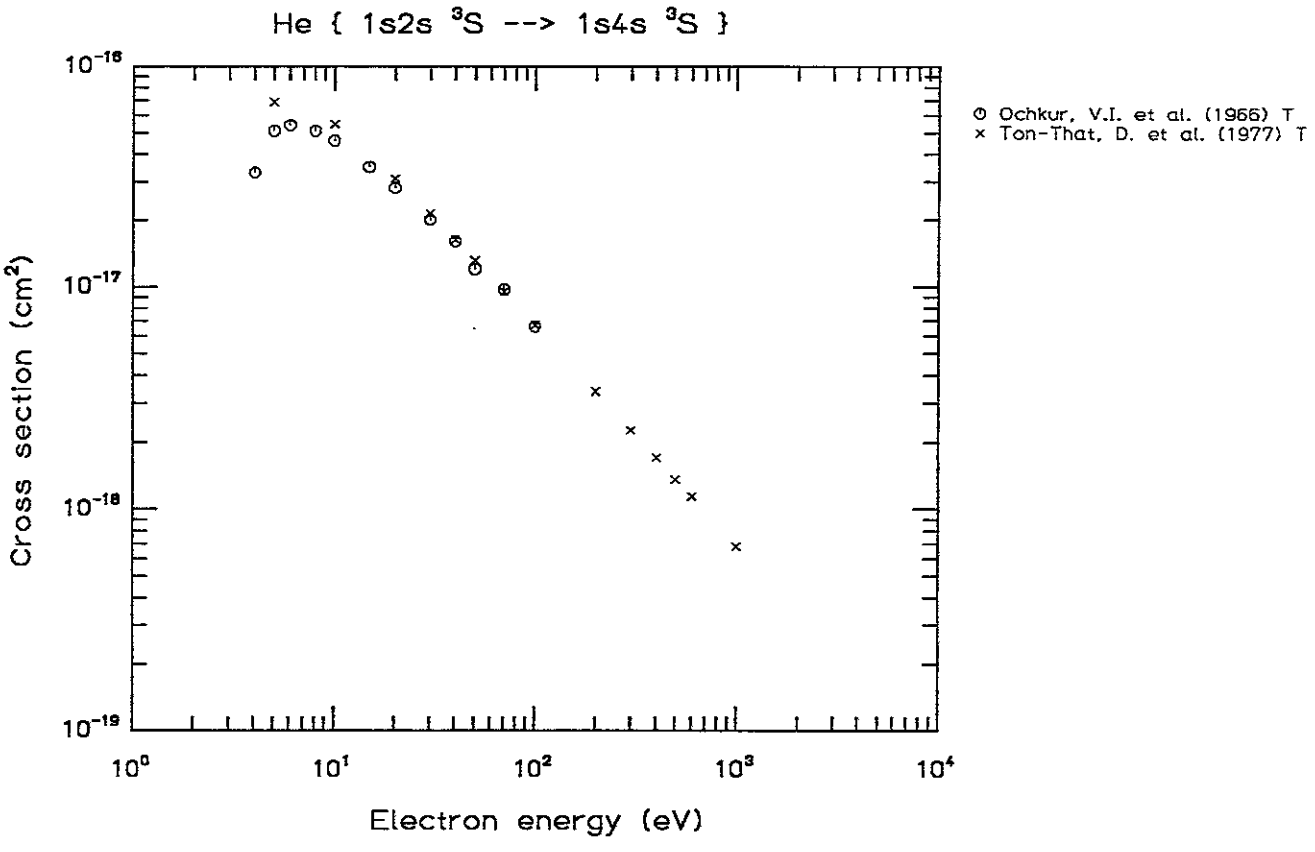

He { 1s2s 3S --> 1s5f 1F }
×10⁻¹⁸
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Cross section (cm²)
10⁰
10¹
10²
10³
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T

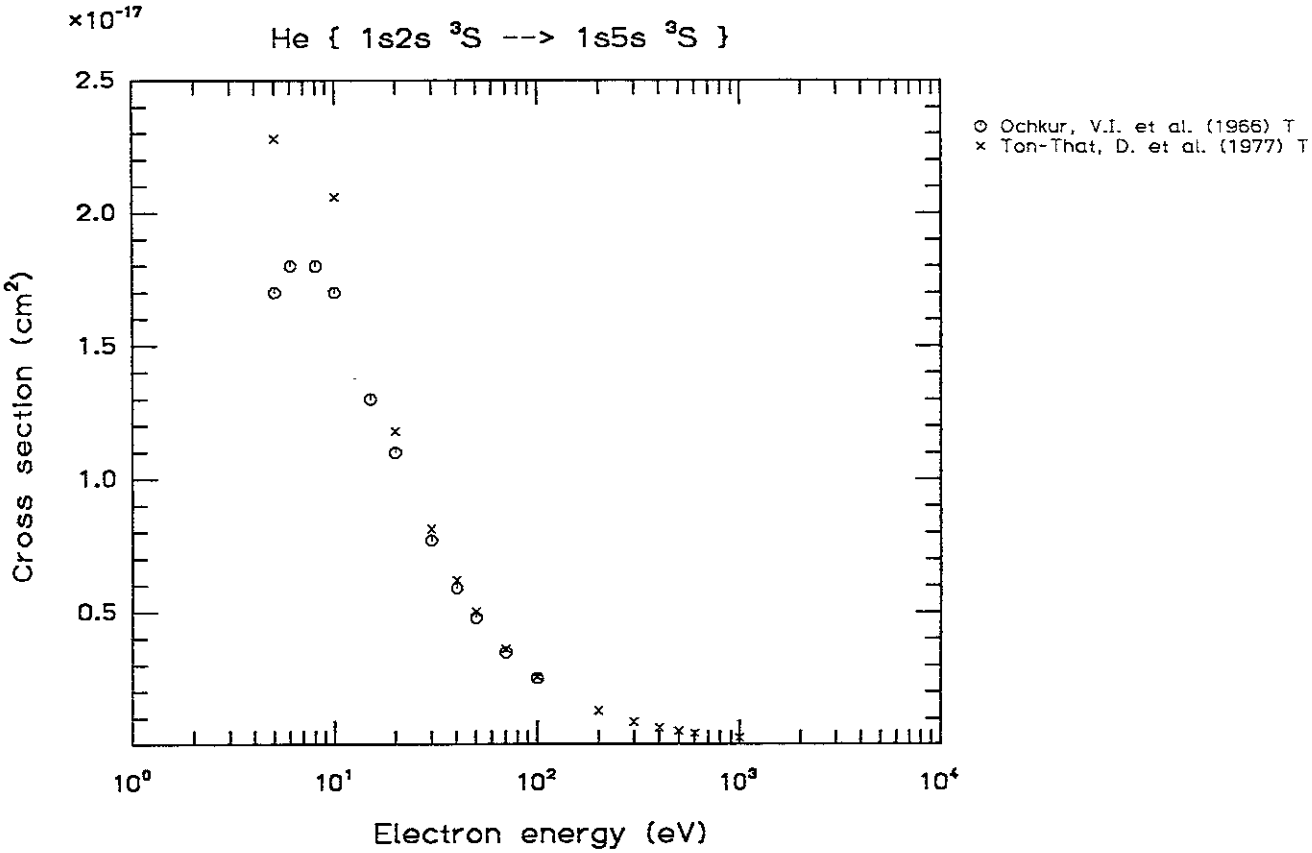

He { 1s2s 3S --> 1s5f 1F }
10⁻¹⁷
10⁻¹⁸
10⁻¹⁹
10⁻²⁰
10⁻²¹
10⁻²²
Cross section (cm²)
10⁰
10¹
10²
10³
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T

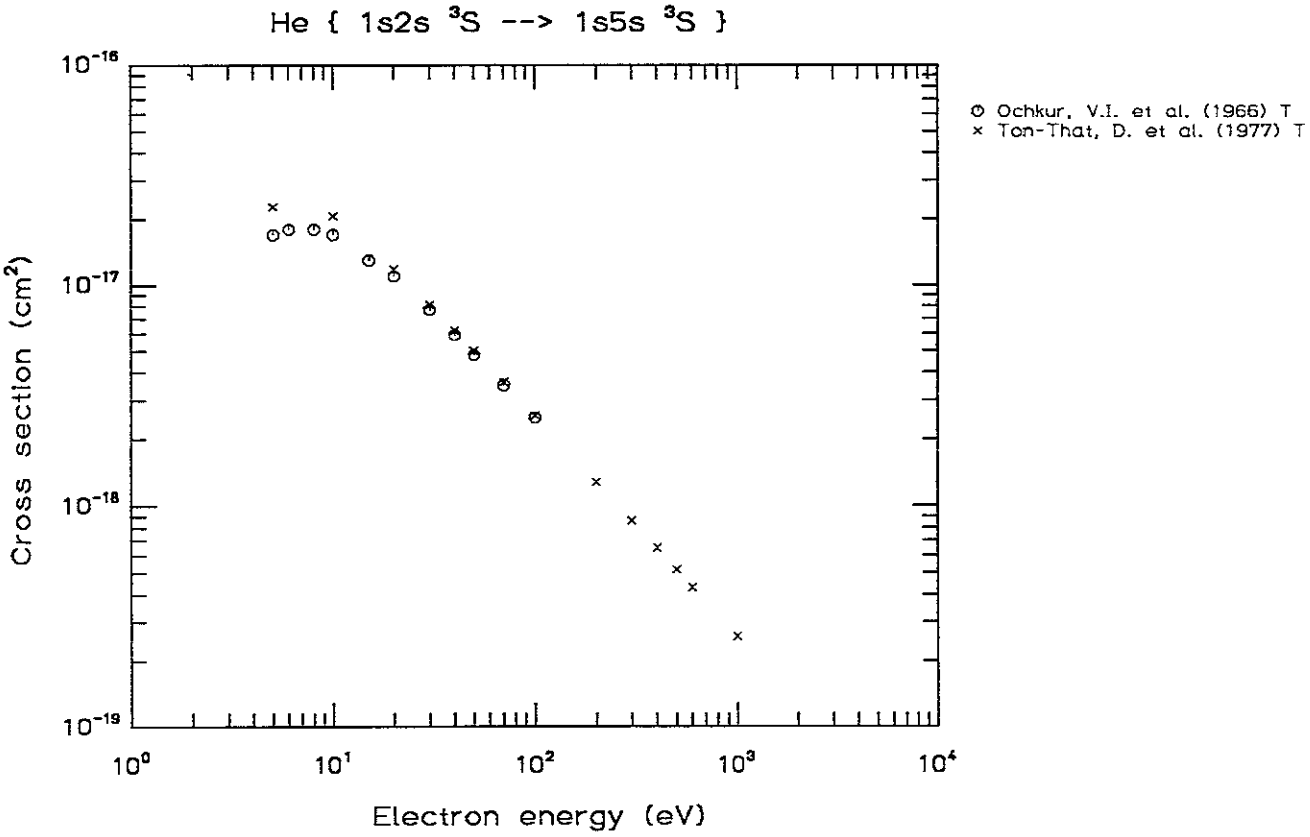

He { 1s2s 3S --> 1s3s 3S }
×10-16
5.0
4.0
3.0
2.0
1.0
Cross section (cm2)
10^0
10^1
10^2
10^3
10^4
Electron energy (eV)
Ochkur, V.I. et al. (1966) T
Kim, Y.K. Inokuti, M. (1969) T
Flannery, M.R. et al. (1975) T
Flannery, M.R. et al. (1975) T
Ton-That, D. et al. (1977) T
Khayrallah, G.A. et al. (1978) T
Khayrallah, G.A. et al. (1978) T
Mathur, K.C. et al. (1987) T
Mansky, E.J. (1990) T

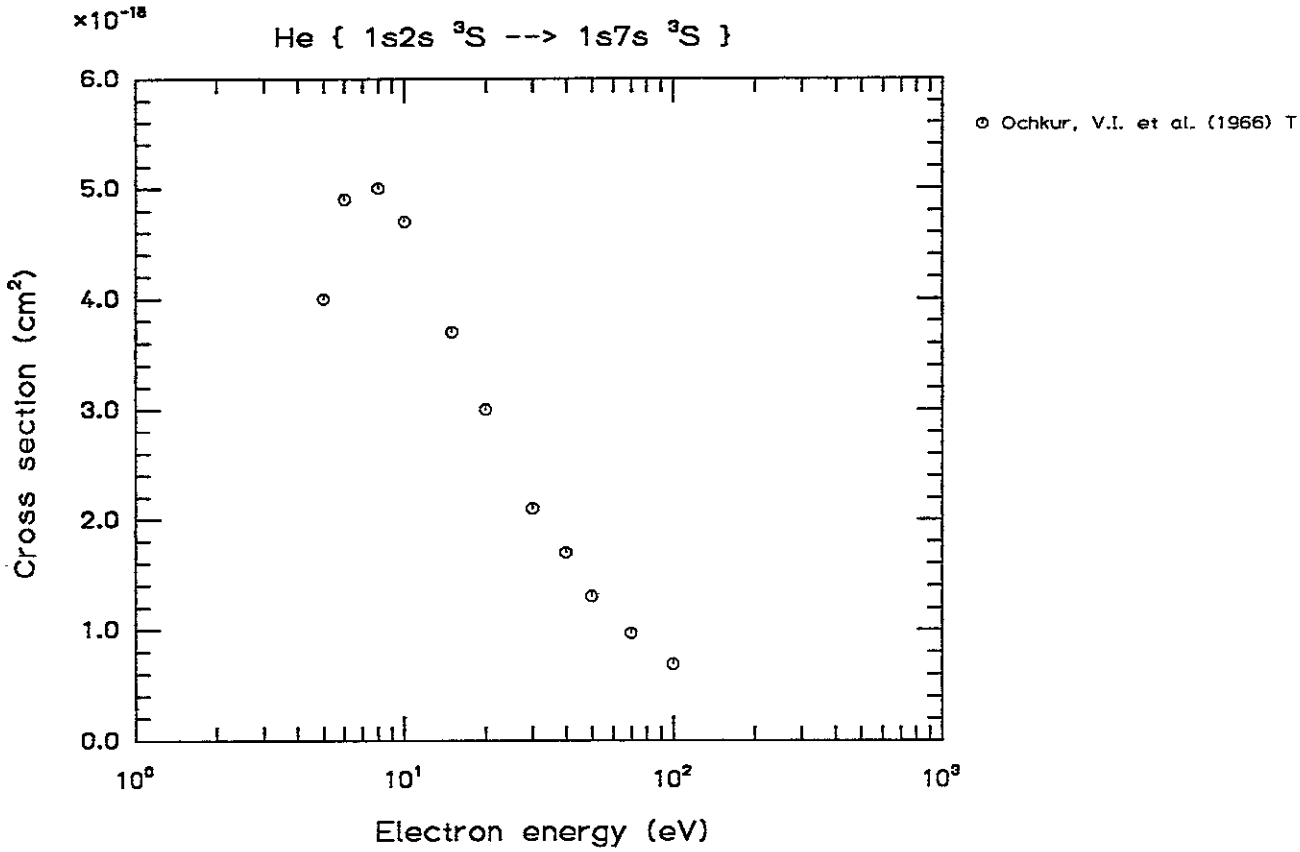

He { 1s2s 3S --> 1s3s 3S }
10-15
10-16
10-17
10-18
Cross section (cm2)
10^0
10^1
10^2
10^3
10^4
Electron energy (eV)
Ochkur, V.I. et al. (1966) T
Kim, Y.K. Inokuti, M. (1969) T
Flannery, M.R. et al. (1975) T
Flannery, M.R. et al. (1975) T
Ton-That, D. et al. (1977) T
Khayrallah, G.A. et al. (1978) T
Khayrallah, G.A. et al. (1978) T
Mathur, K.C. et al. (1987) T
Mansky, E.J. (1990) T

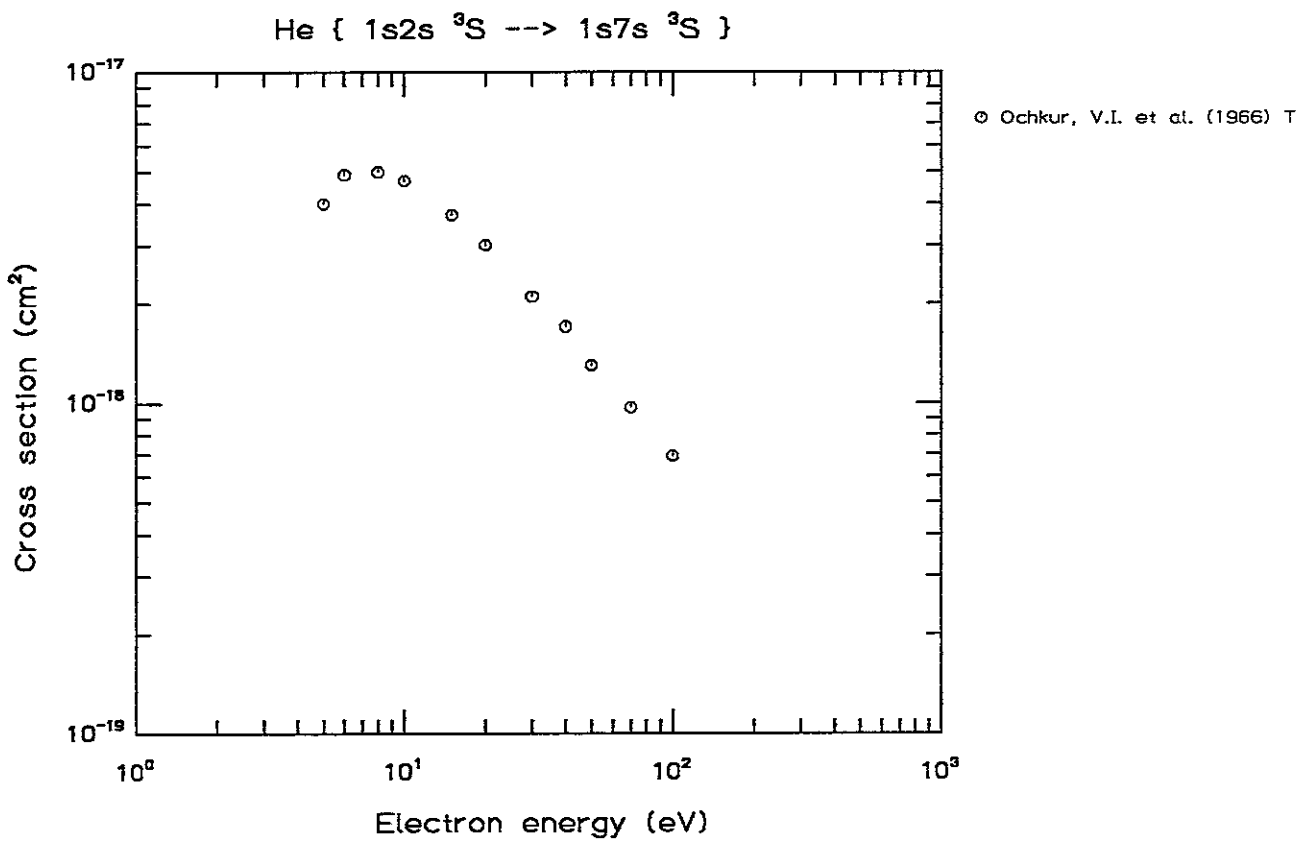

He { 1s2s 3S --> 1s4s 3S }
×10-17
8.0
6.0
4.0
2.0
0.0
Cross section (cm2)
10⁰
10¹
10²
10³
10⁴
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T
× Ton-That, D. et al. (1977) T

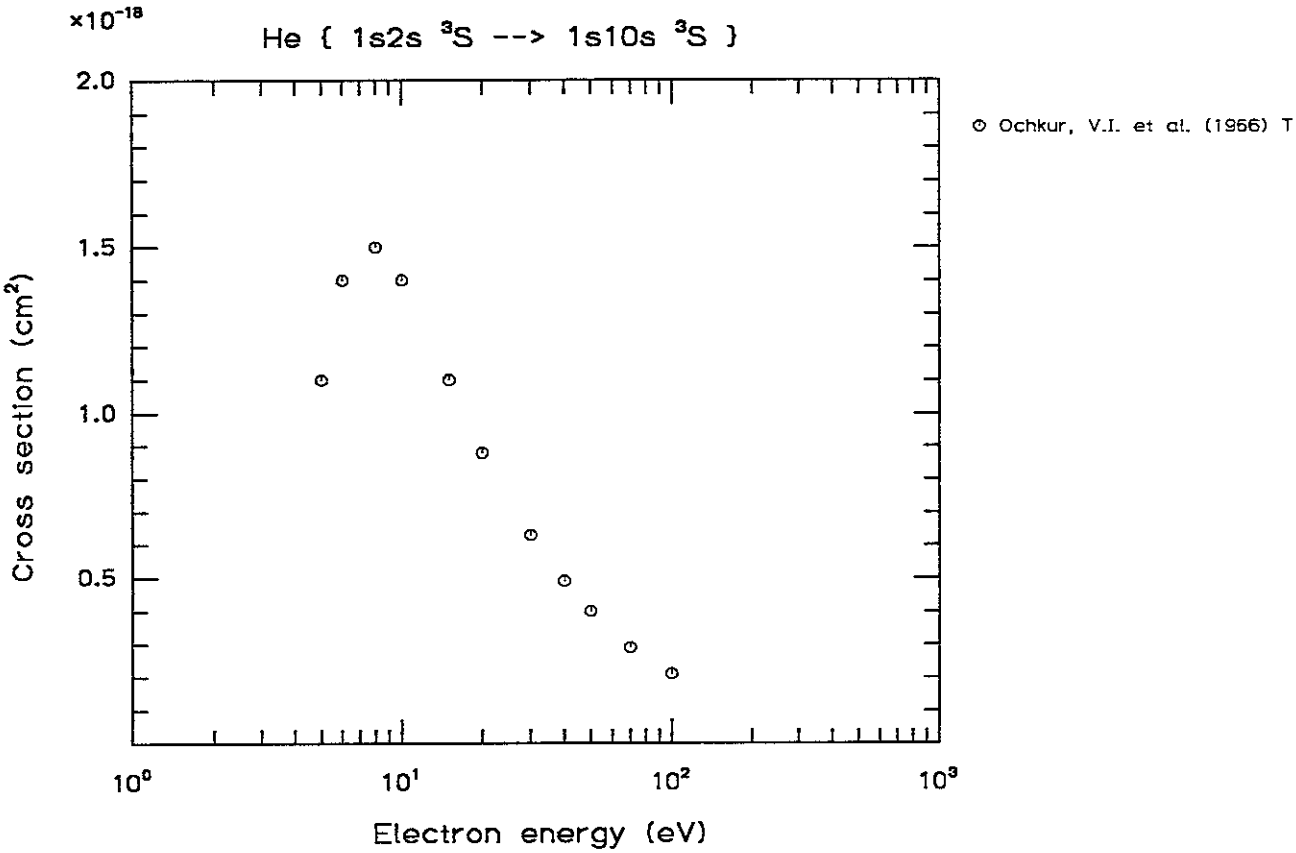

He { 1s2s 3S --> 1s4s 3S }
10-16
10-17
10-18
10-19
Cross section (cm2)
10⁰
10¹
10²
10³
10⁴
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T
× Ton-That, D. et al. (1977) T

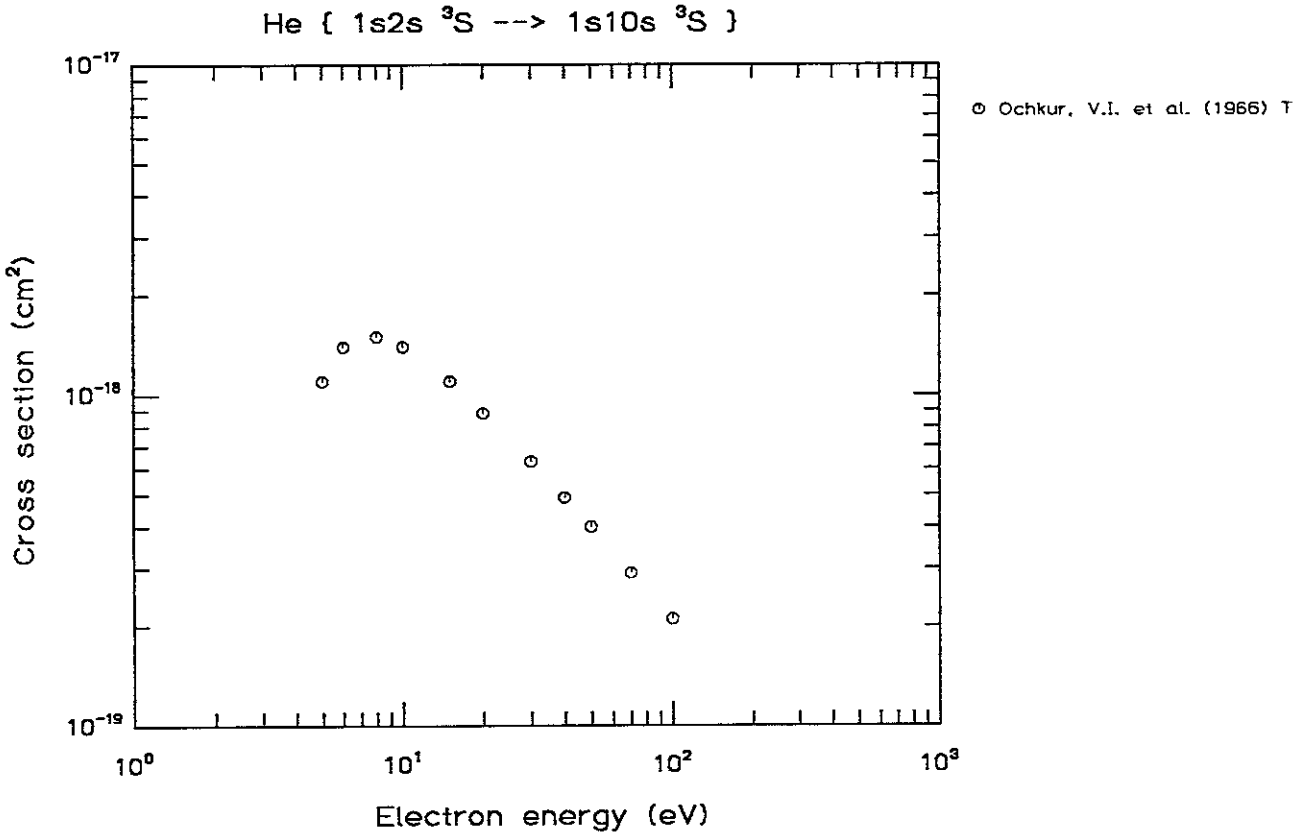

He { 1s2s 3S --> 1s5s 3S }
×10-17
2.5
2.0
1.5
1.0
0.5
Cross section (cm2)
10^0
10^1
10^2
10^3
10^4
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T
× Ton-That, D. et al. (1977) T

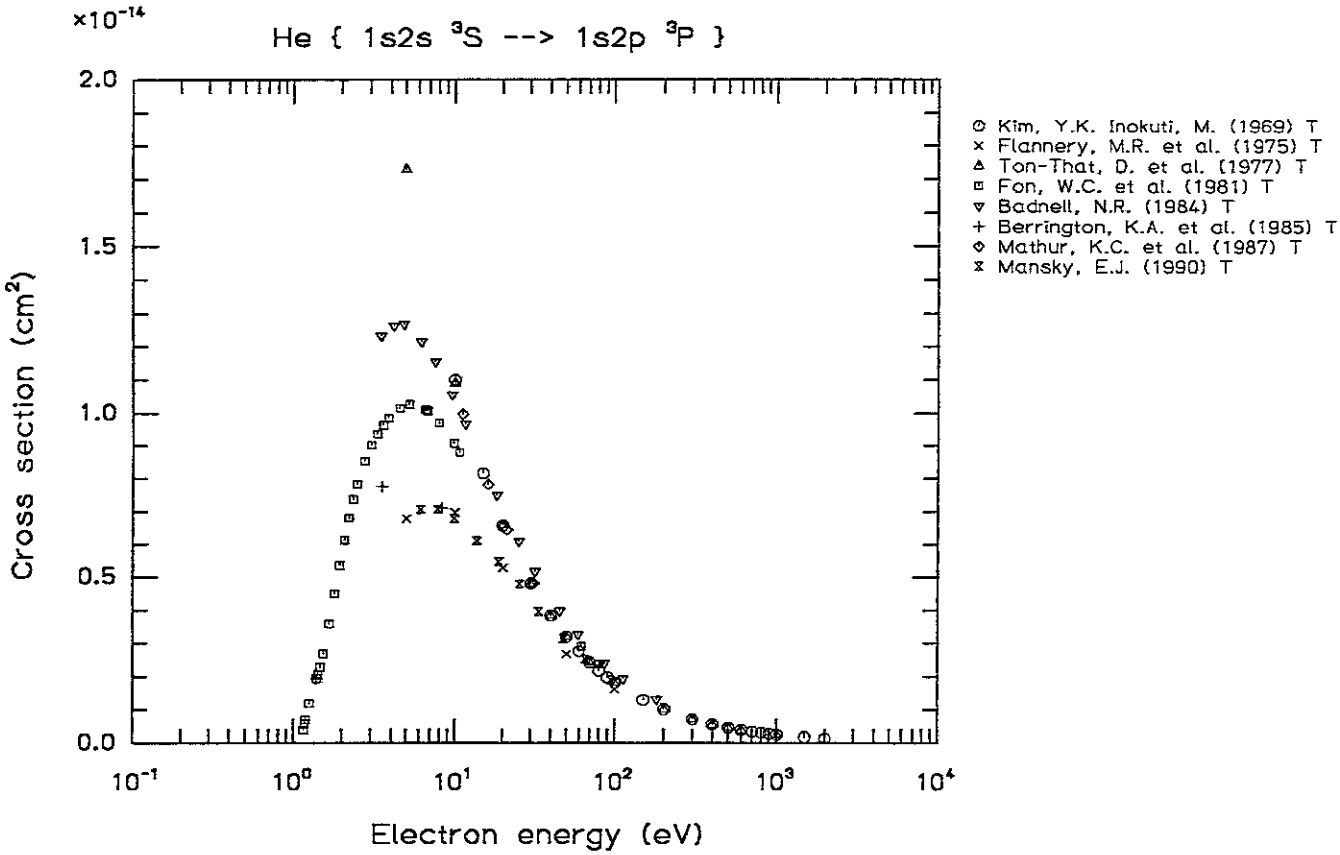

He { 1s2s 3S --> 1s5s 3S }
10-16
10-17
10-18
10-19
Cross section (cm2)
10^0
10^1
10^2
10^3
10^4
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T
× Ton-That, D. et al. (1977) T

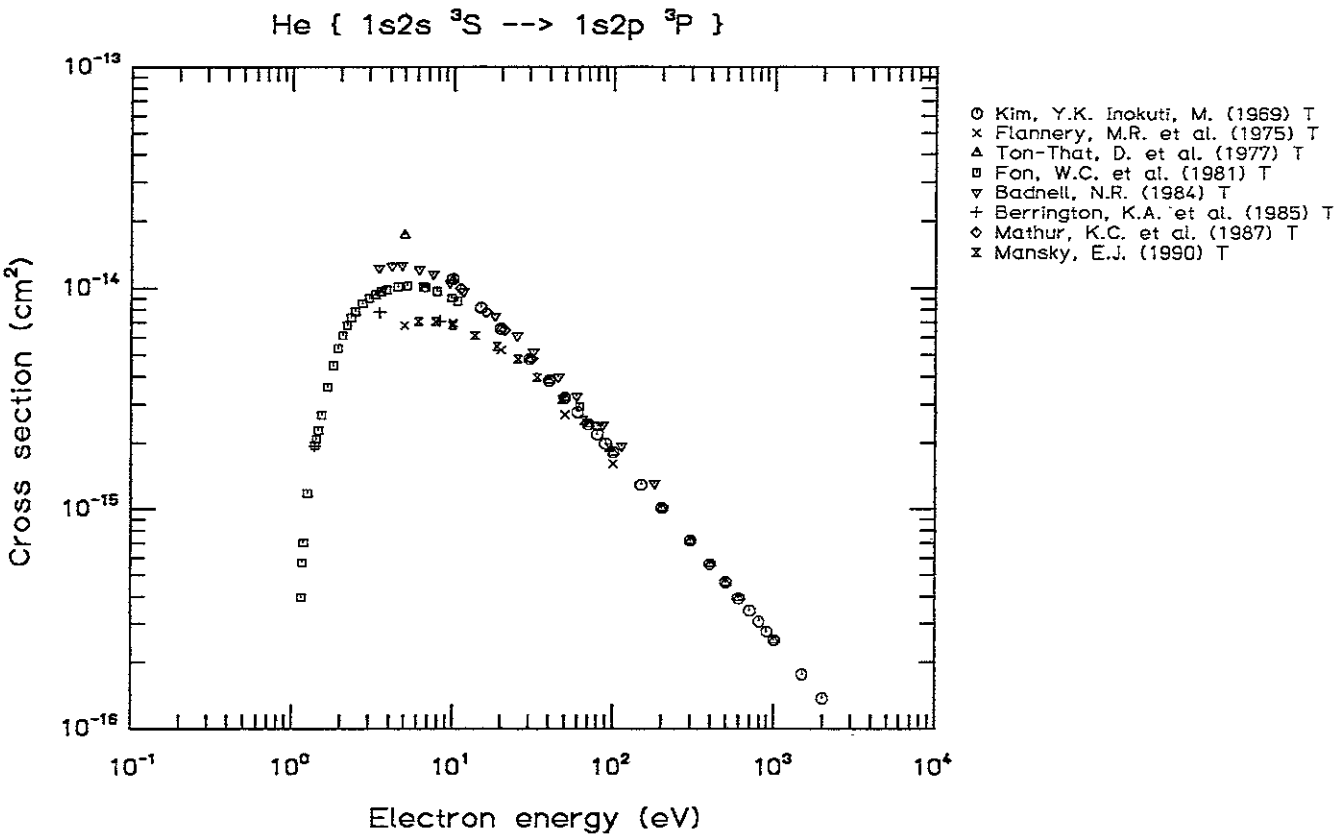

He { 1s2s 3S --> 1s7s 3S }
×10-18
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Cross section (cm2)
10⁰
10¹
10²
10³
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T

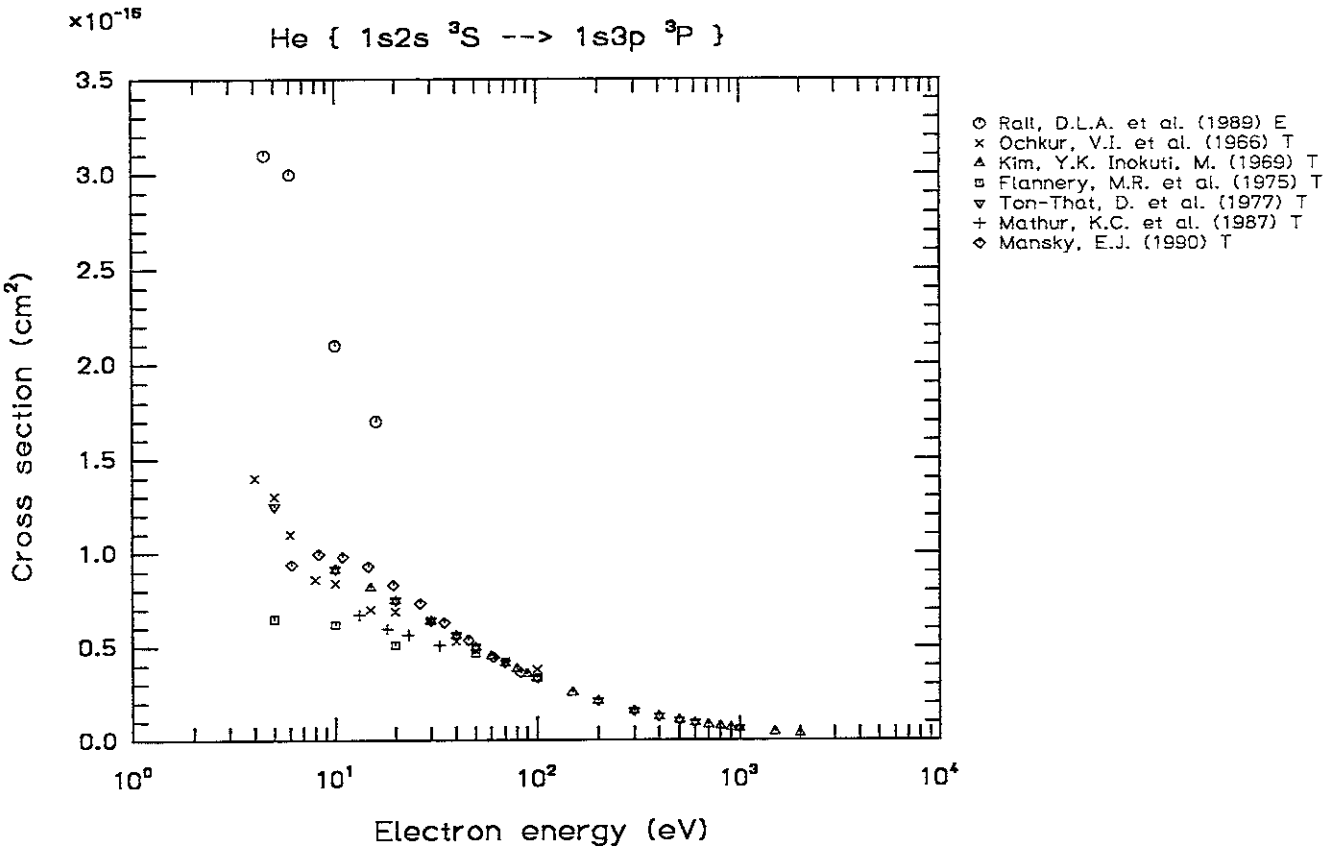

He { 1s2s 3S --> 1s7s 3S }
10-17
10-18
10-19
Cross section (cm2)
10⁰
10¹
10²
10³
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T

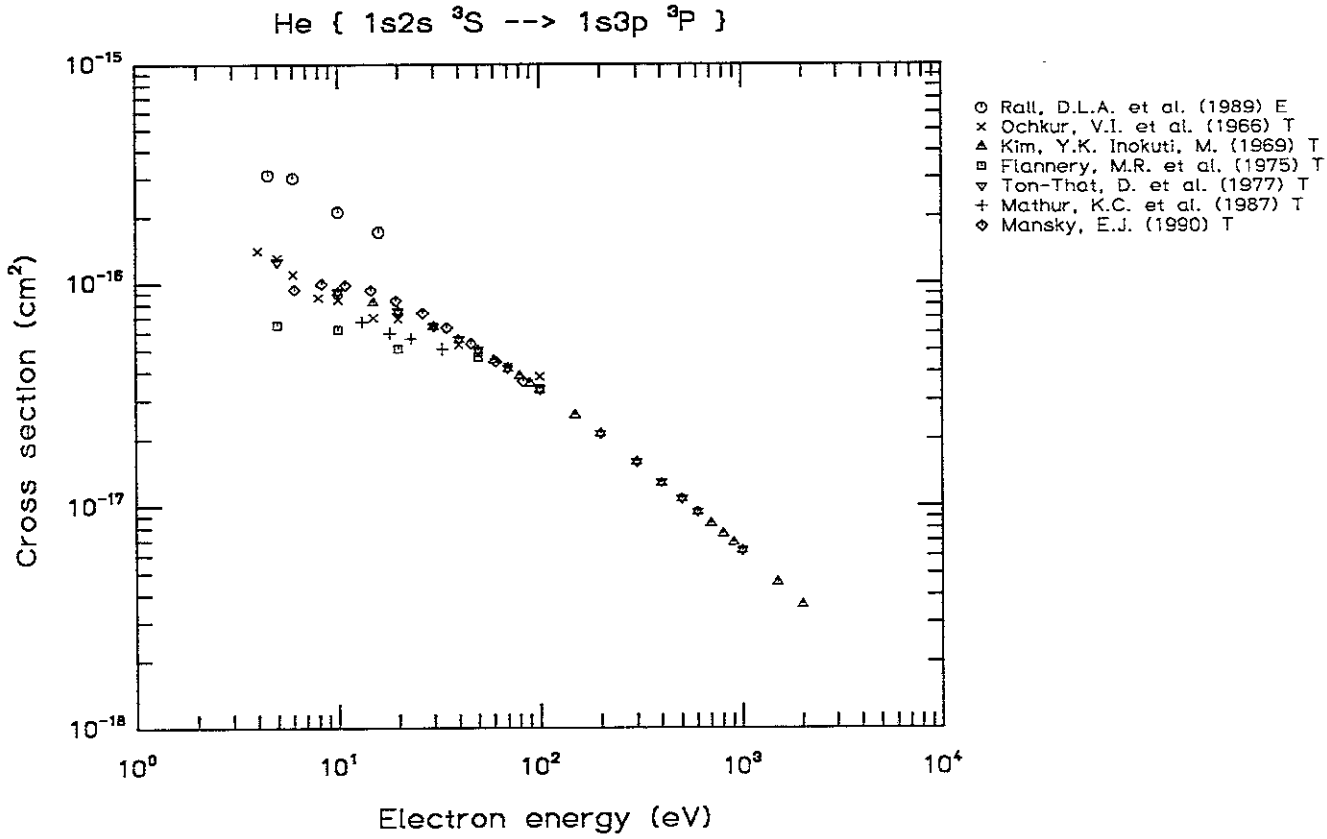

He { 1s2s ³S --> 1s10s ³S }
×10⁻¹⁸
2.0
1.5
1.0
0.5
Cross section (cm²)
10⁰
10¹
10²
10³
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T

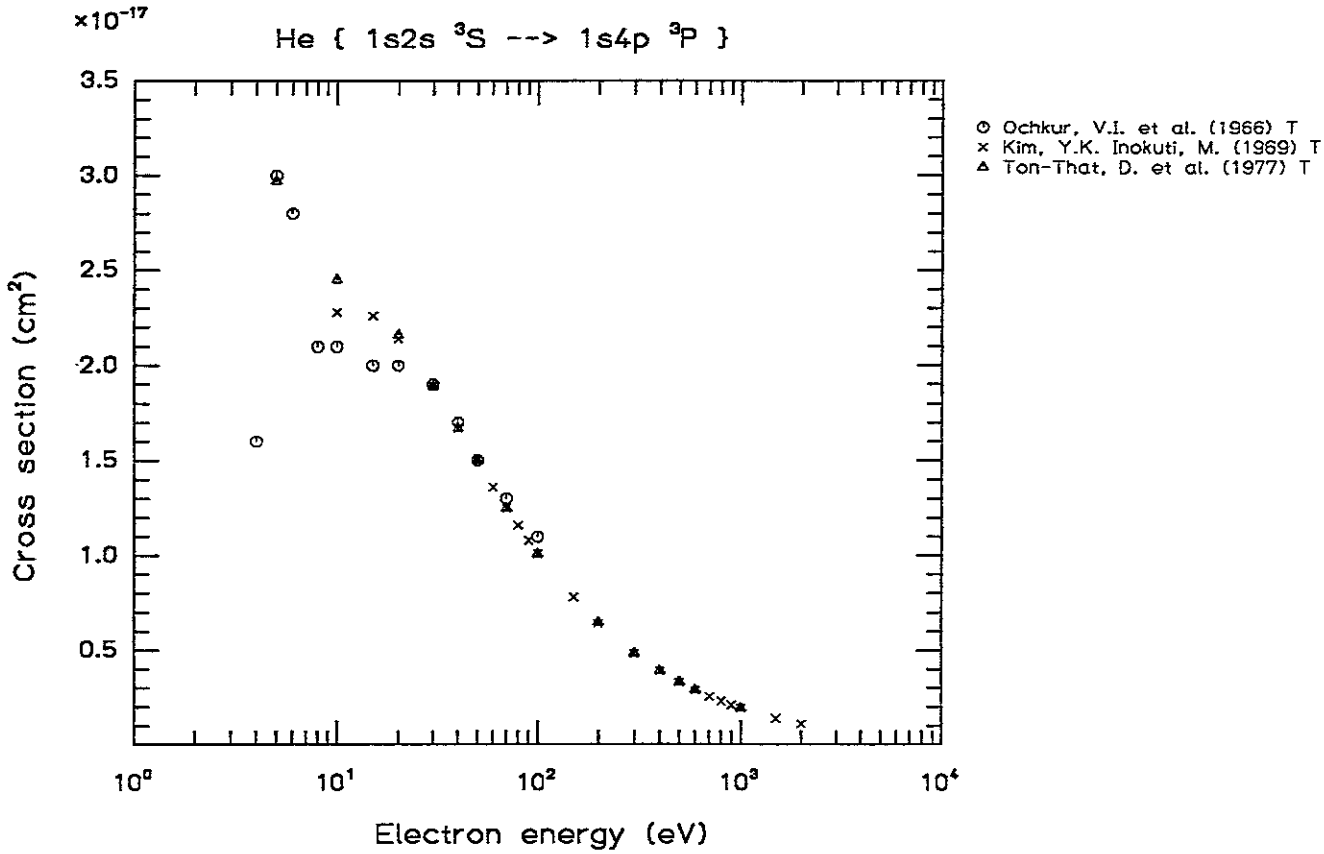

He { 1s2s ³S --> 1s10s ³S }
10⁻¹⁷
10⁻¹⁸
10⁻¹⁹
Cross section (cm²)
10⁰
10¹
10²
10³
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T

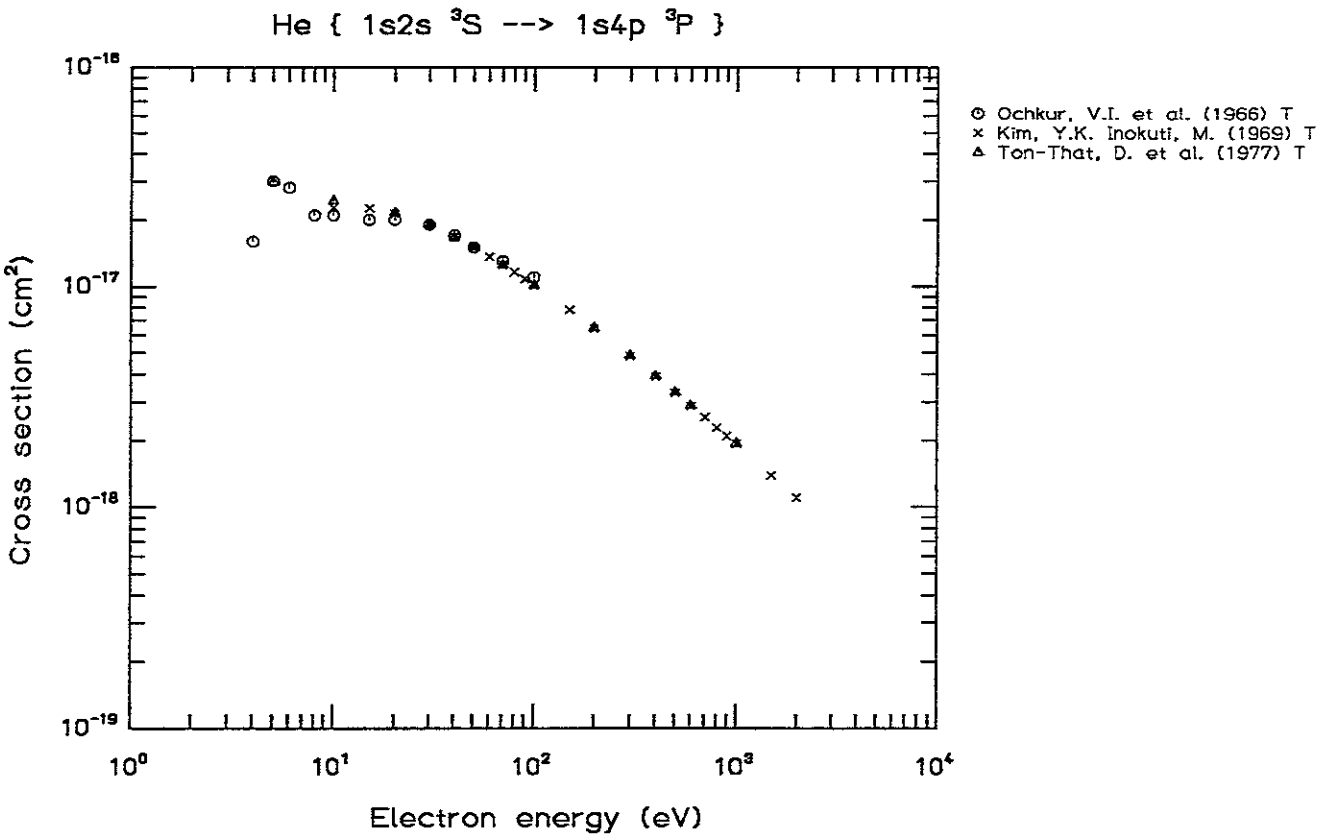

He { 1s2s 3S --> 1s2p 3P }
×10-14
2.0
1.5
1.0
0.5
0.0
Cross section (cm2)
10-1
100
101
102
103
104
Electron energy (eV)
Kim, Y.K. Inokuti, M. (1969) T
Flannery, M.R. et al. (1975) T
Ton-That, D. et al. (1977) T
Fon, W.C. et al. (1981) T
Badnell, N.R. (1984) T
Berrington, K.A. et al. (1985) T
Mathur, K.C. et al. (1987) T
Mansky, E.J. (1990) T

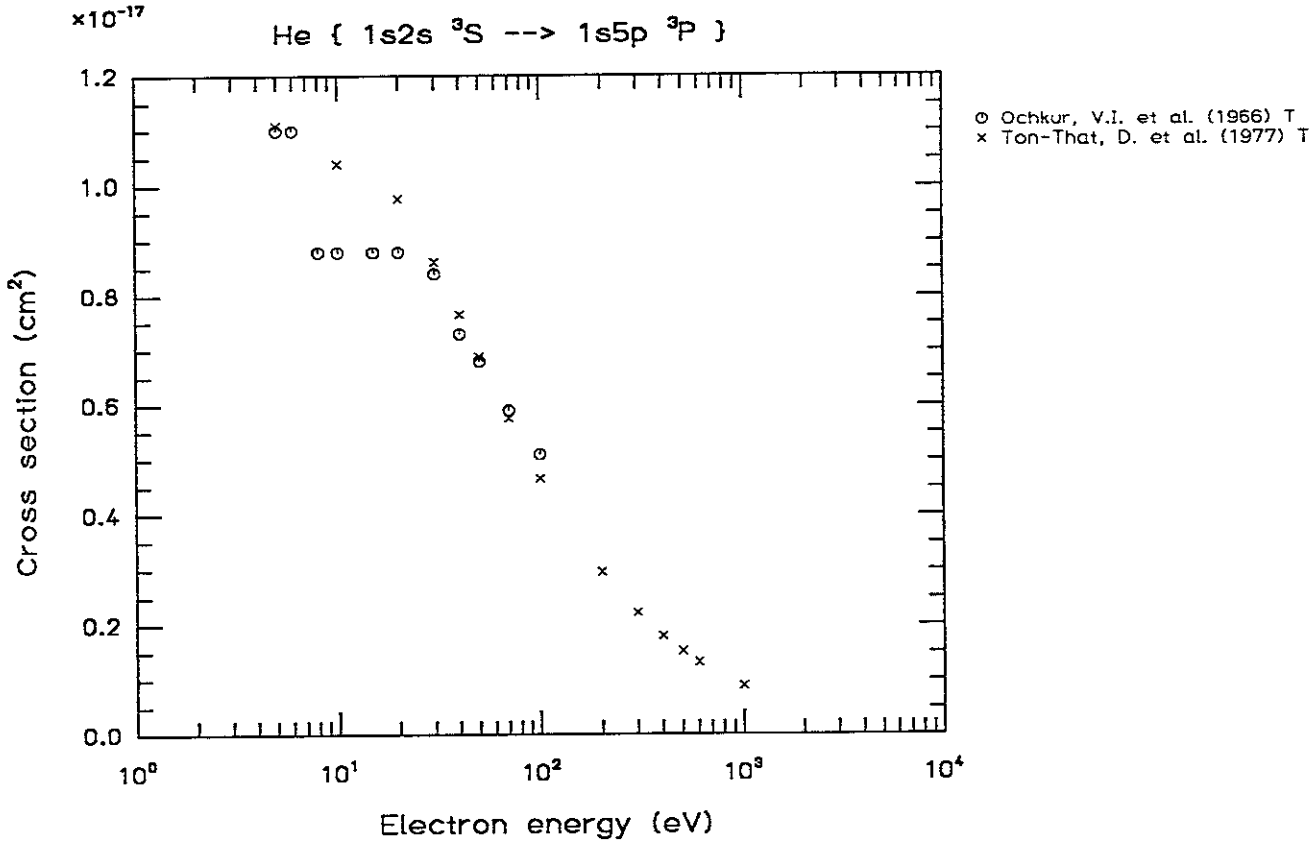

He { 1s2s 3S --> 1s2p 3P }
10-13
10-14
10-15
10-16
Cross section (cm2)
10-1
100
101
102
103
104
Electron energy (eV)
Kim, Y.K. Inokuti, M. (1969) T
Flannery, M.R. et al. (1975) T
Ton-That, D. et al. (1977) T
Fon, W.C. et al. (1981) T
Badnell, N.R. (1984) T
Berrington, K.A. et al. (1985) T
Mathur, K.C. et al. (1987) T
Mansky, E.J. (1990) T

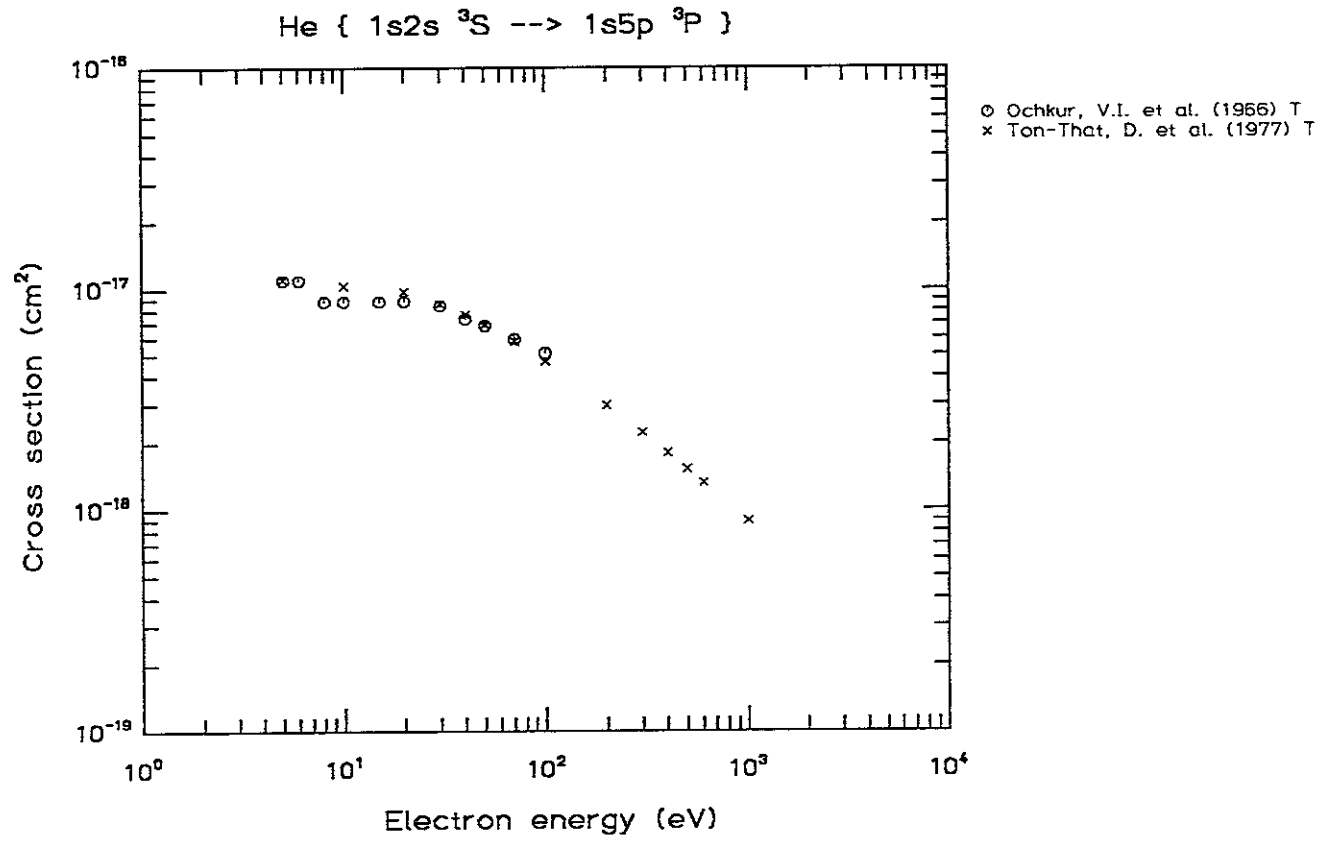

He { 1s2s 3S --> 1s3p 3P }
×10-15
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Cross section (cm2)
10^0
10^1
10^2
10^3
10^4
Electron energy (eV)
Rall, D.L.A. et al. (1989) E
Ochkur, V.I. et al. (1966) T
Kim, Y.K. Inokuti, M. (1969) T
Flannery, M.R. et al. (1975) T
Ton-That, D. et al. (1977) T
Mathur, K.C. et al. (1987) T
Mansky, E.J. (1990) T

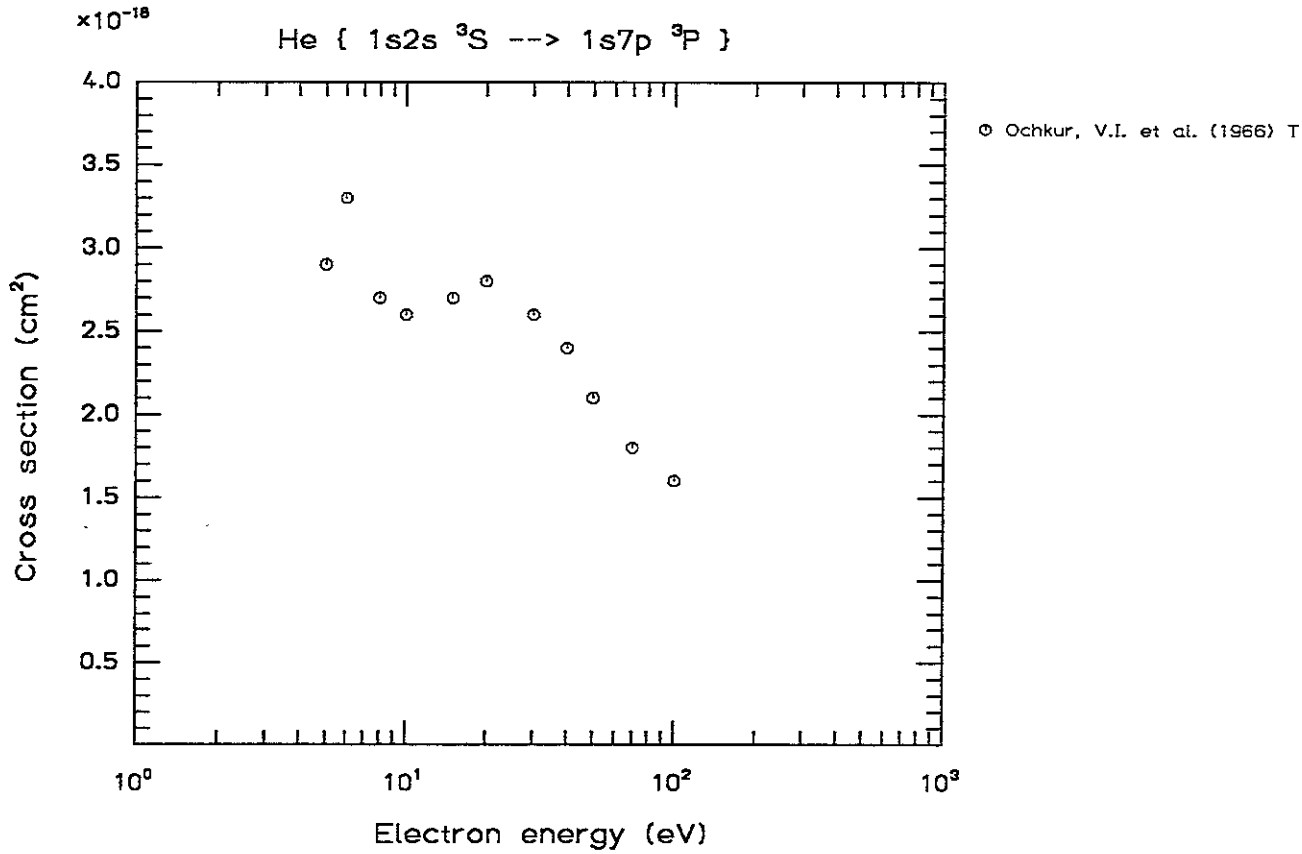

He { 1s2s 3S --> 1s3p 3P }
10-15
10-16
10-17
10-18
Cross section (cm2)
10^0
10^1
10^2
10^3
10^4
Electron energy (eV)
Rall, D.L.A. et al. (1989) E
Ochkur, V.I. et al. (1966) T
Kim, Y.K. Inokuti, M. (1969) T
Flannery, M.R. et al. (1975) T
Ton-That, D. et al. (1977) T
Mathur, K.C. et al. (1987) T
Mansky, E.J. (1990) T

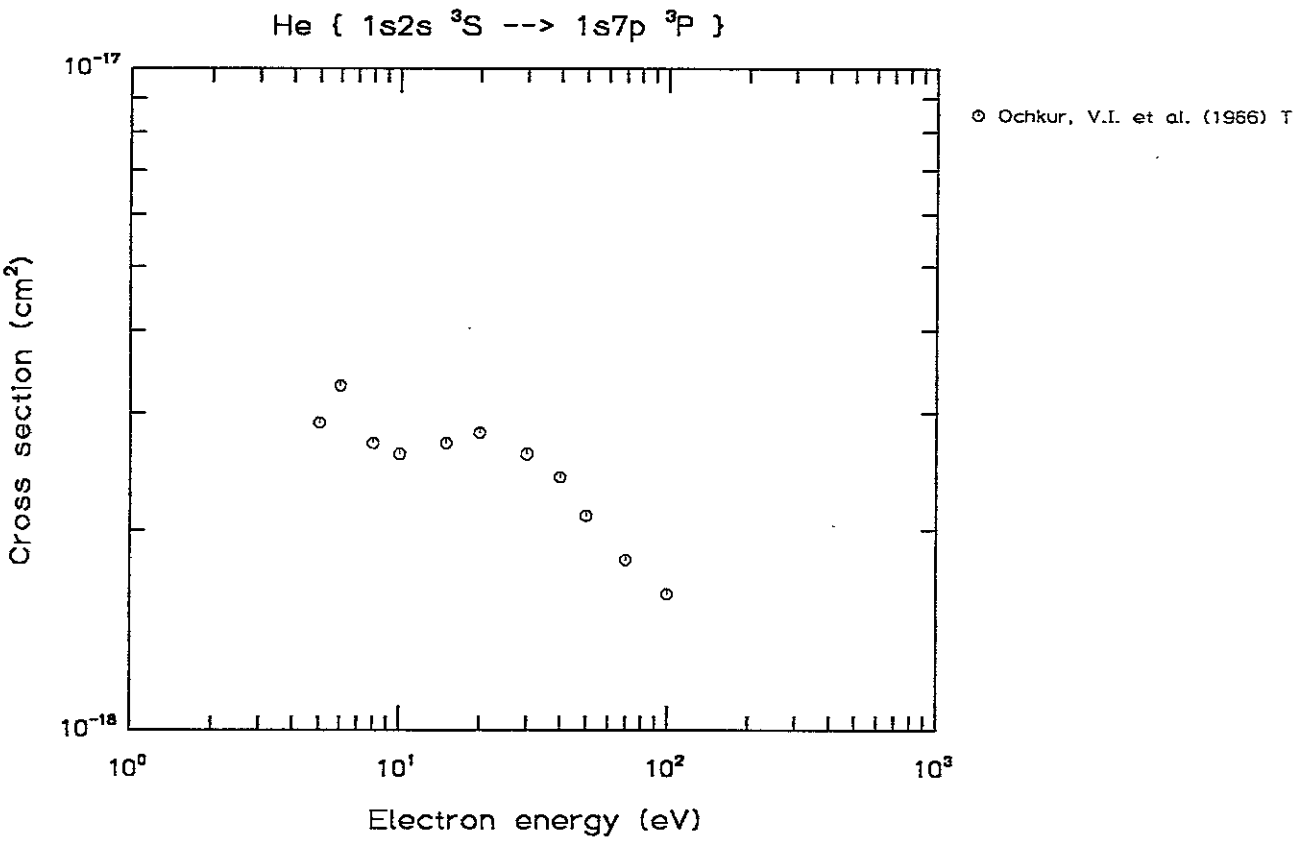

He { 1s2s 3S --> 1s4p 3P }
×10-17
3.5
3.0
2.5
2.0
1.5
1.0
0.5
Cross section (cm2)
10⁰
10¹
10²
10³
10⁴
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T
× Kim, Y.K. Inokuti, M. (1969) T
△ Ton-That, D. et al. (1977) T

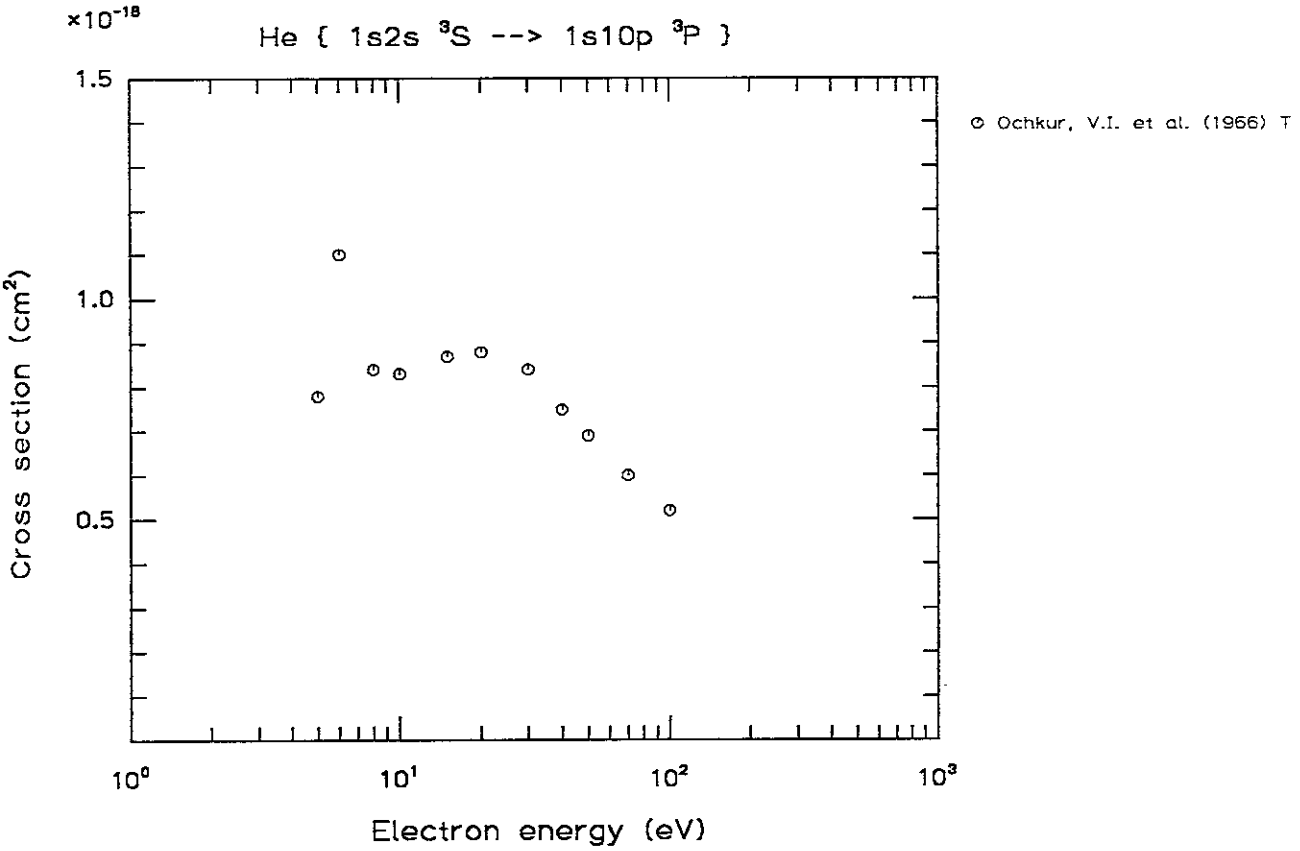

He { 1s2s 3S --> 1s4p 3P }
10-16
10-17
10-18
10-19
Cross section (cm2)
10⁰
10¹
10²
10³
10⁴
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T
× Kim, Y.K. Inokuti, M. (1969) T
△ Ton-That, D. et al. (1977) T

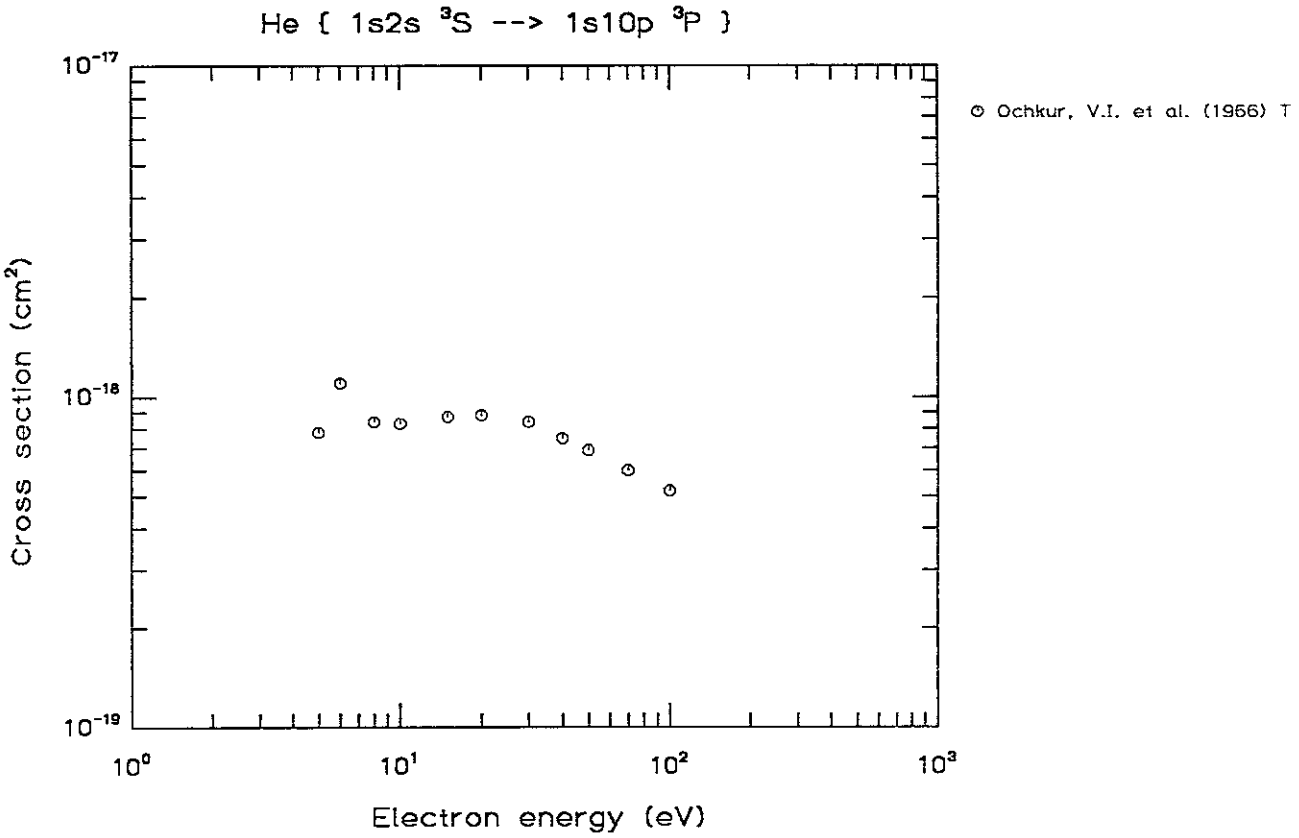

He { 1s2s 3S --> 1s5p 3P }
×10-17
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Cross section (cm2)
10^0
10^1
10^2
10^3
10^4
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T
× Ton-That, D. et al. (1977) T

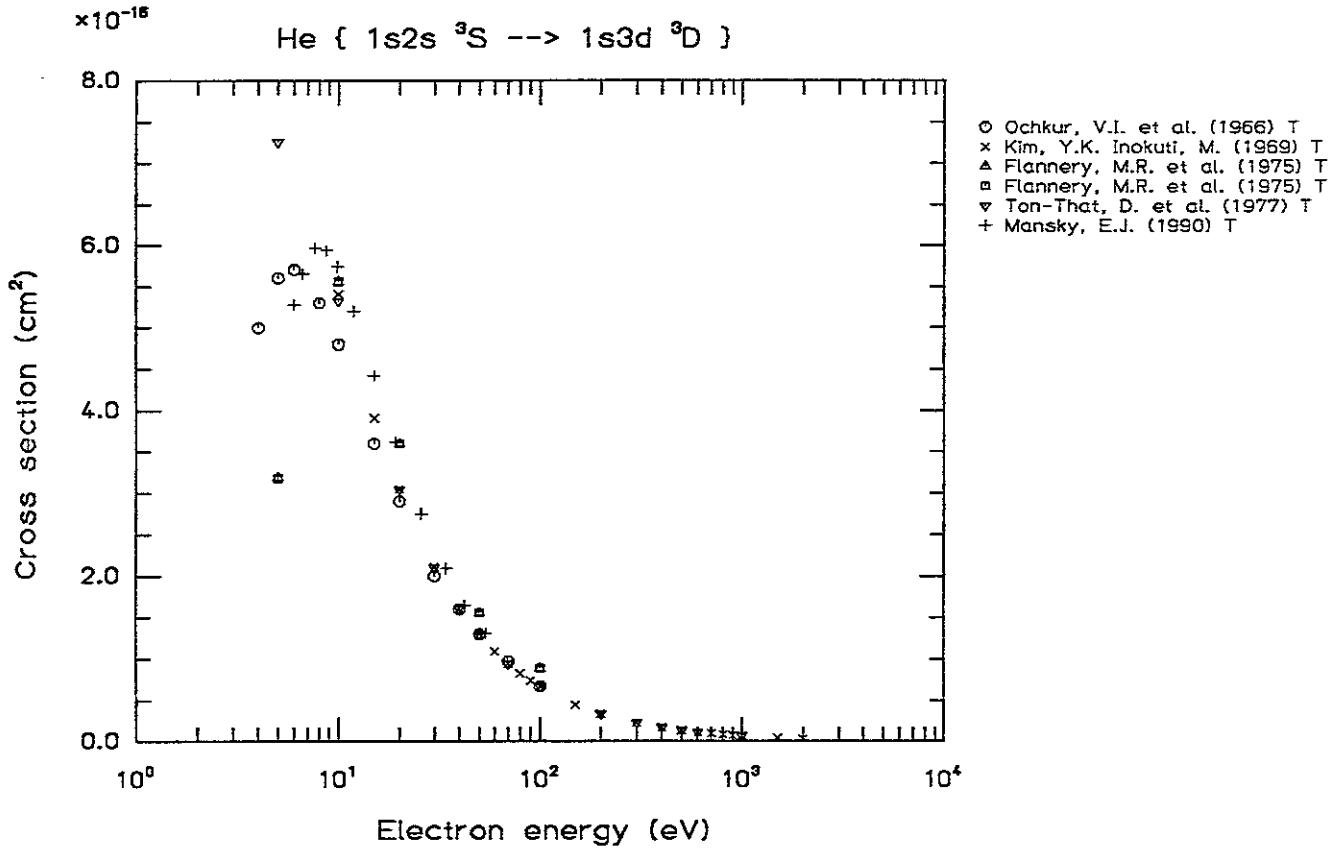

He { 1s2s 3S --> 1s5p 3P }
10-16
10-17
10-18
10-19
Cross section (cm2)
10^0
10^1
10^2
10^3
10^4
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T
× Ton-That, D. et al. (1977) T

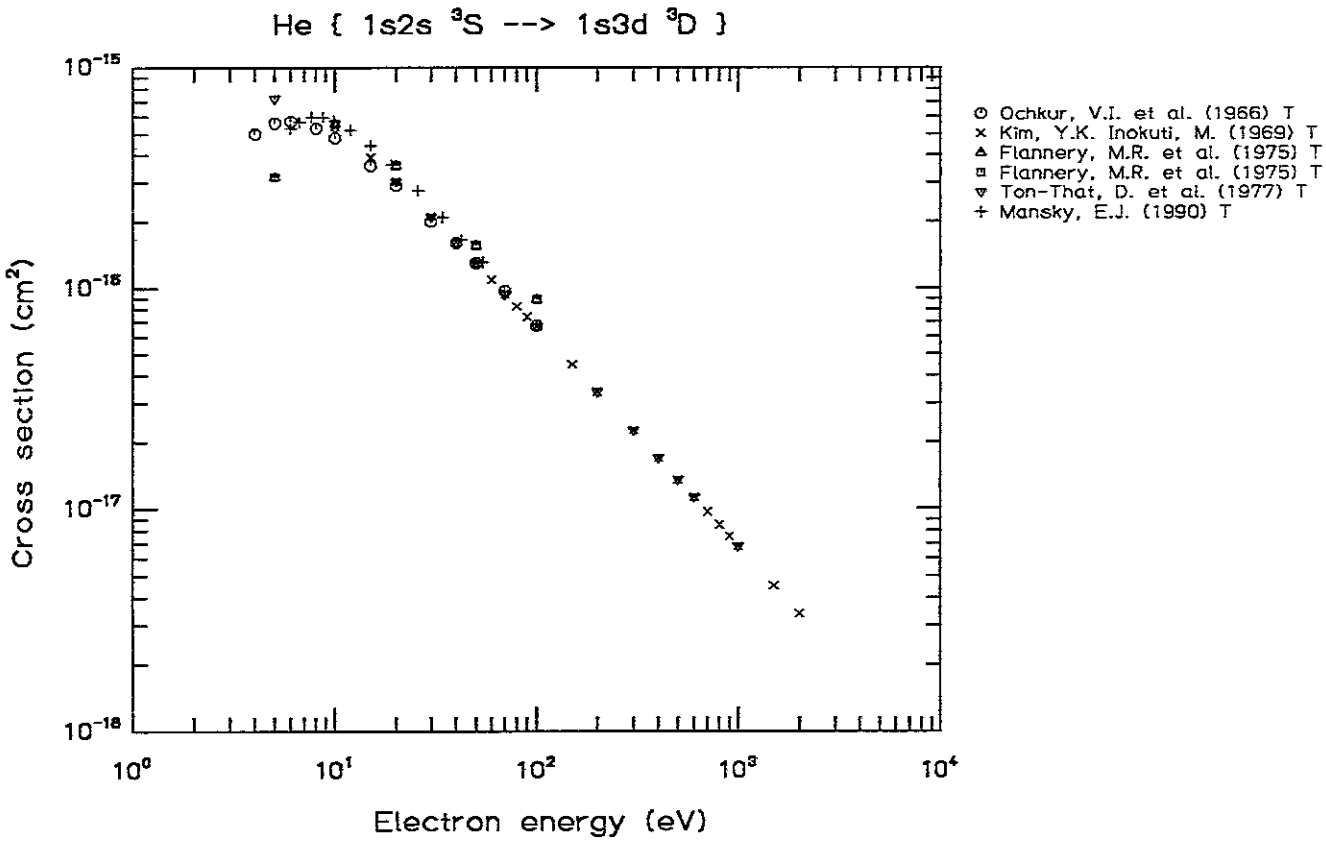

He { 1s2s 3S --> 1s7p 3P }
x10-18
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
Cross section (cm2)
10^0
10^1
10^2
10^3
Electron energy (eV)
Ochkur, V.I. et al. (1966) T

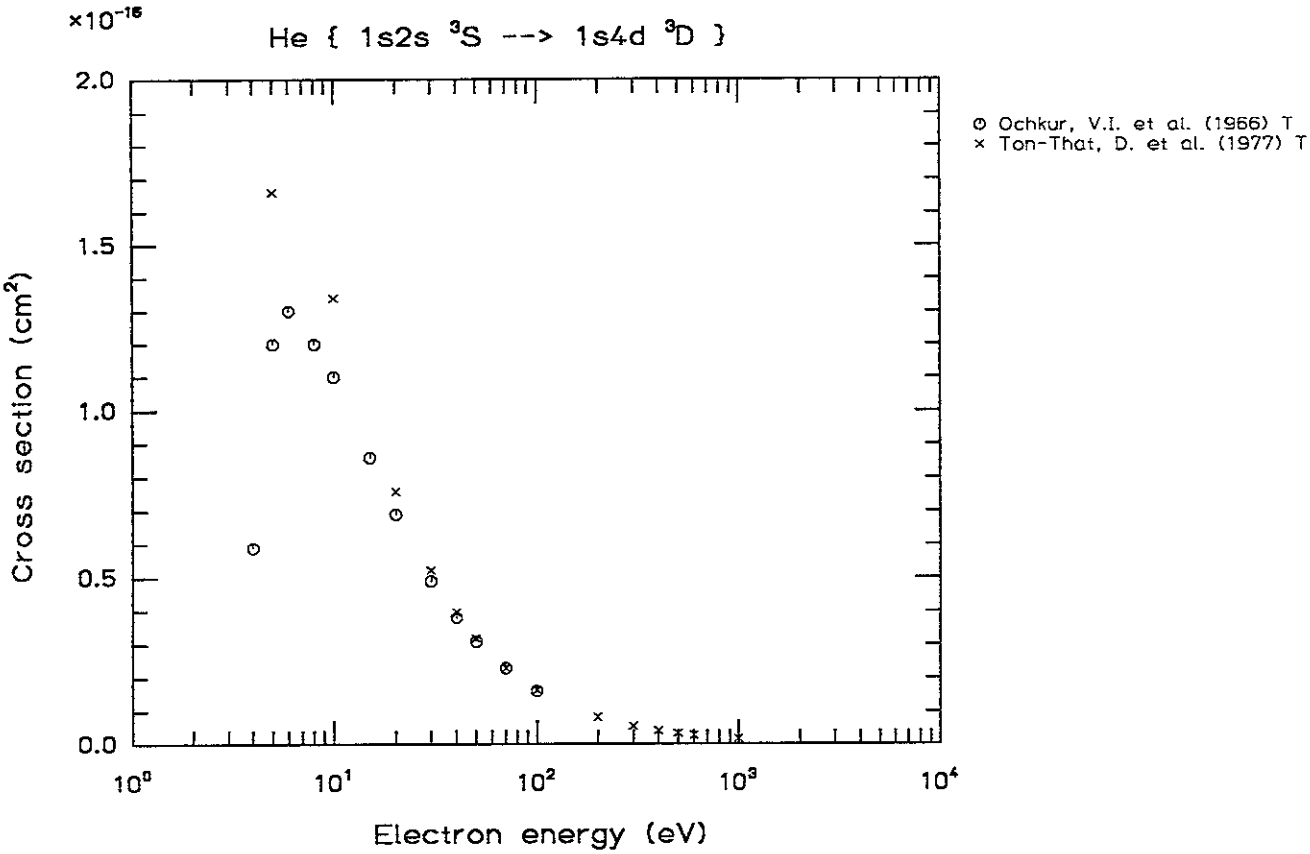

He { 1s2s 3S --> 1s7p 3P }
10-17
10-18
Cross section (cm2)
10^0
10^1
10^2
10^3
Electron energy (eV)
Ochkur, V.I. et al. (1966) T

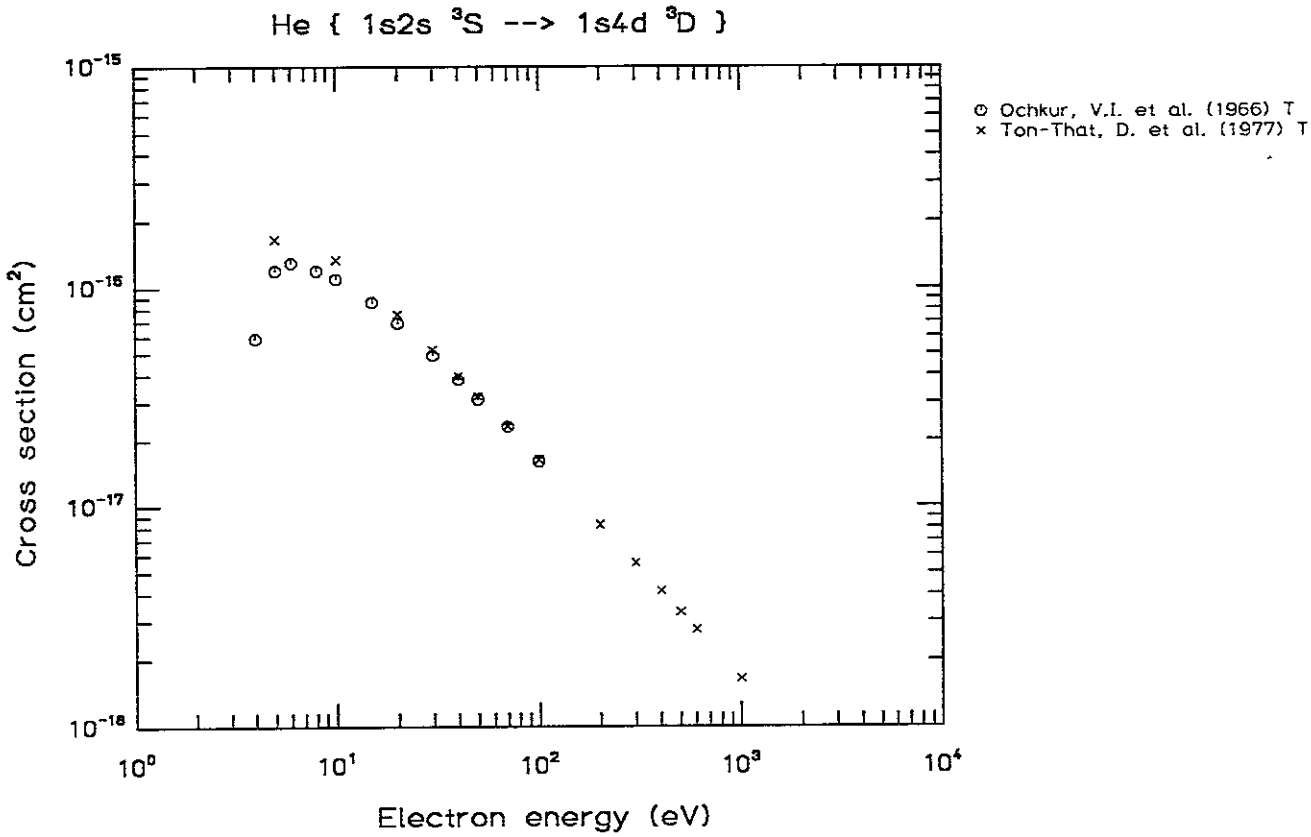

He { 1s2s 3S --> 1s10p 3P }
×10-18
1.5
1.0
0.5
Cross section (cm2)
10^0
10^1
10^2
10^3
Electron energy (eV)
Ochkur, V.I. et al. (1966) T

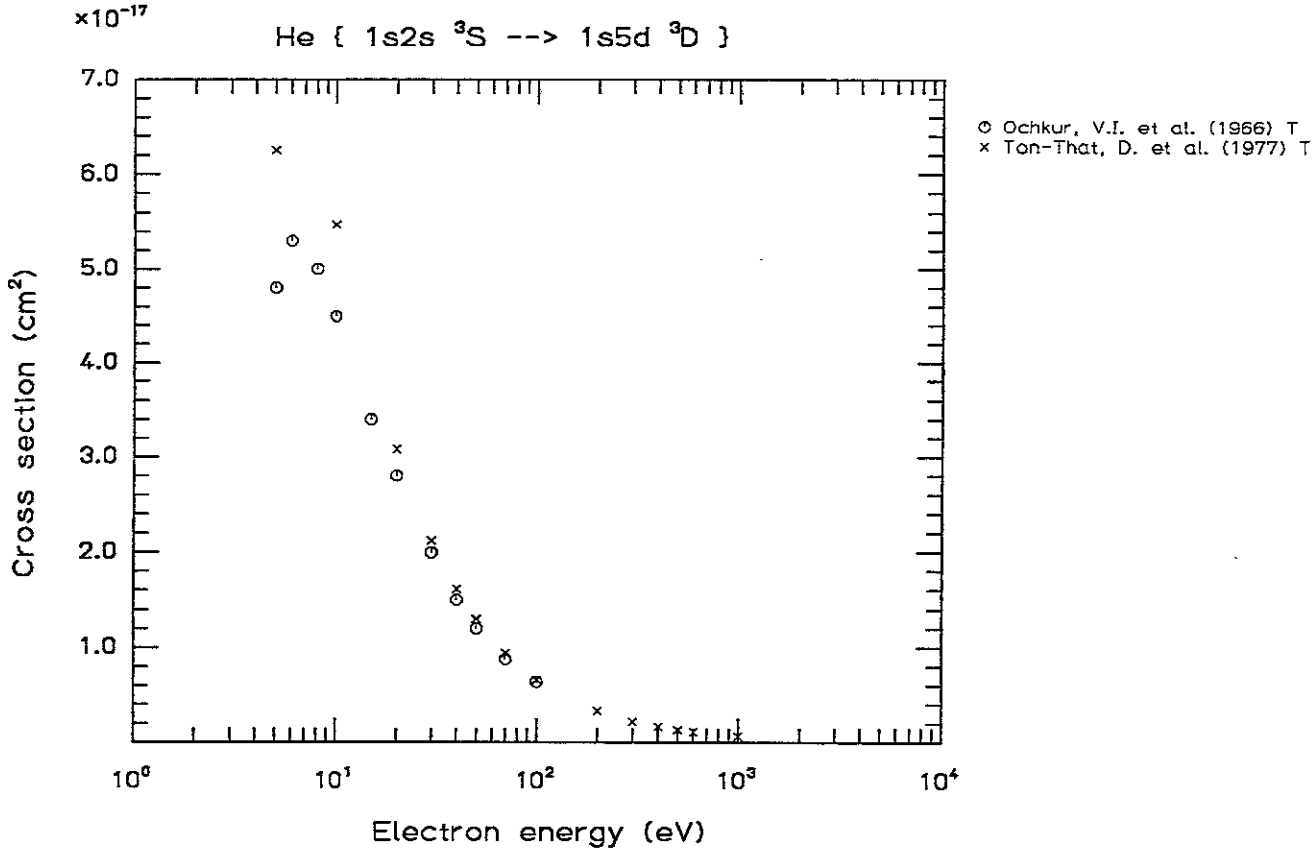

He { 1s2s 3S --> 1s10p 3P }
10-17
10-18
10-19
Cross section (cm2)
10^0
10^1
10^2
10^3
Electron energy (eV)
Ochkur, V.I. et al. (1966) T

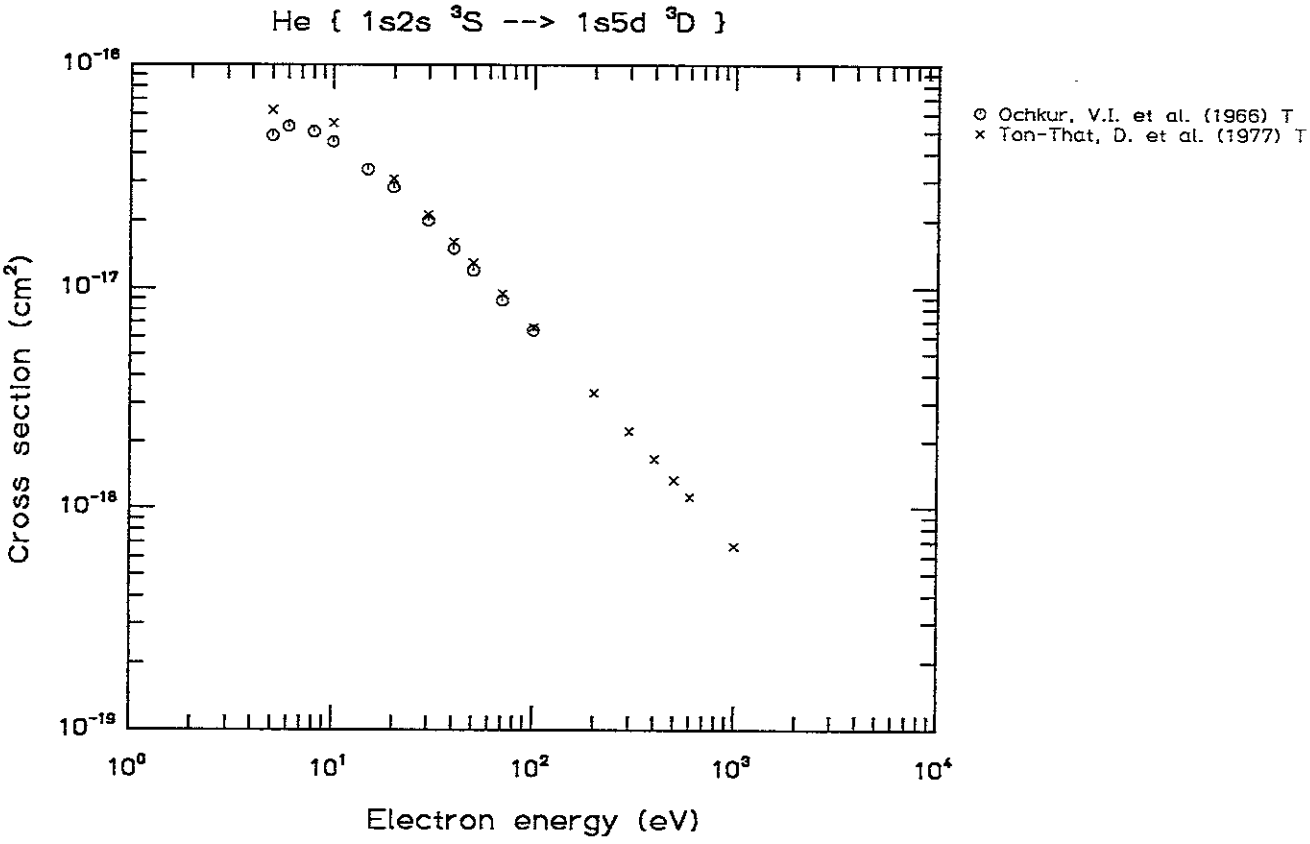

He { 1s2s 3S --> 1s3d 3D }
×10-16
8.0
6.0
4.0
2.0
0.0
Cross section (cm2)
10^0
10^1
10^2
10^3
10^4
Electron energy (eV)
Ochkur, V.I. et al. (1966) T
Kim, Y.K. Inokuti, M. (1969) T
Flannery, M.R. et al. (1975) T
Flannery, M.R. et al. (1975) T
Ton-That, D. et al. (1977) T
Mansky, E.J. (1990) T

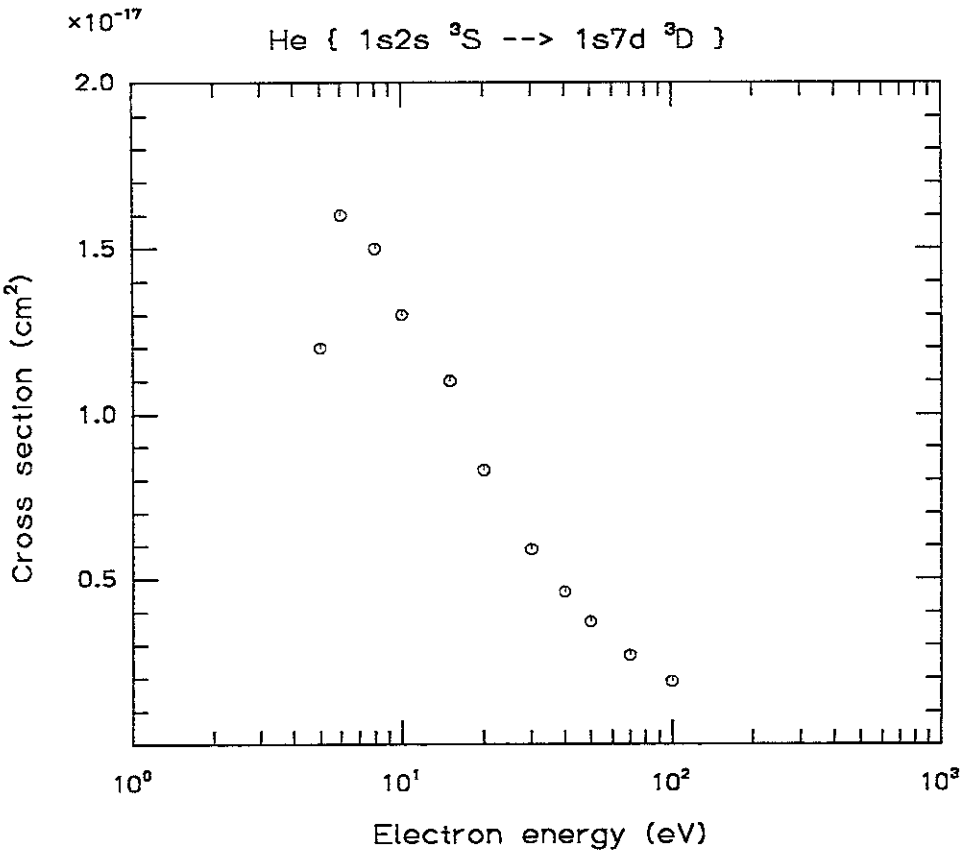

He { 1s2s 3S --> 1s3d 3D }
10-15
10-16
10-17
10-18
Cross section (cm2)
10^0
10^1
10^2
10^3
10^4
Electron energy (eV)
Ochkur, V.I. et al. (1966) T
Kim, Y.K. Inokuti, M. (1969) T
Flannery, M.R. et al. (1975) T
Flannery, M.R. et al. (1975) T
Ton-That, D. et al. (1977) T
Mansky, E.J. (1990) T


He { 1s2s 3S --> 1s4d 3D }
×10-16
2.0
1.5
1.0
0.5
0.0
Cross section (cm2)
10^0
10^1
10^2
10^3
10^4
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T
× Ton-That, D. et al. (1977) T

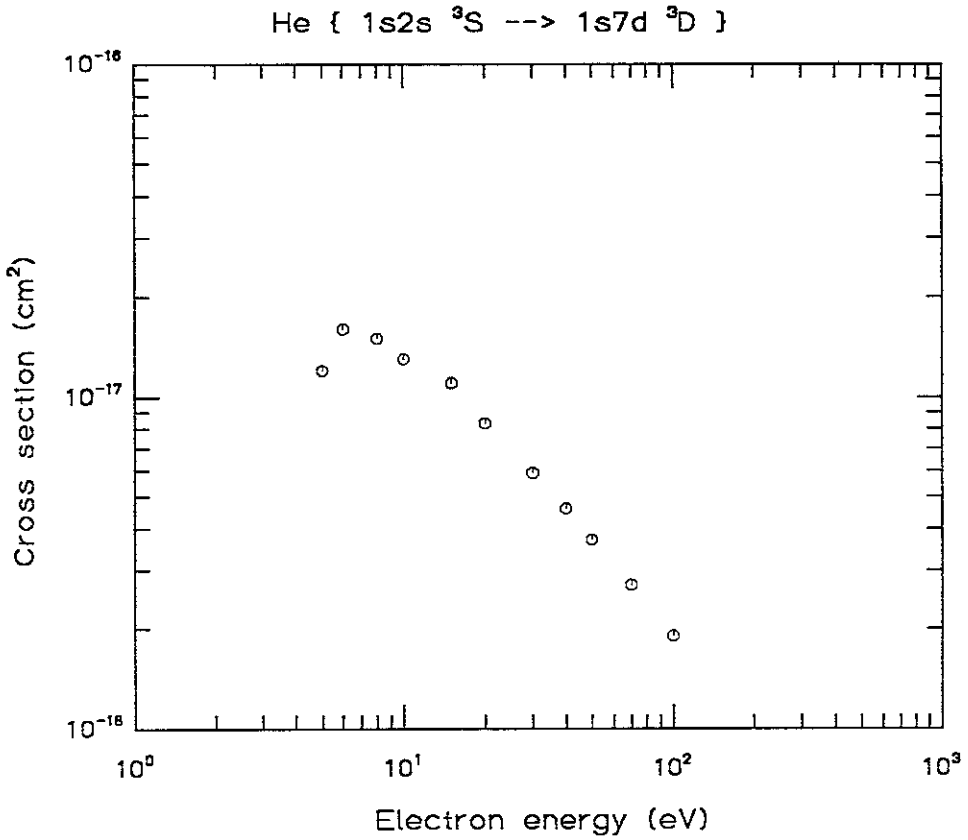

He { 1s2s 3S --> 1s4d 3D }
10-15
10-16
10-17
10-18
Cross section (cm2)
10^0
10^1
10^2
10^3
10^4
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T
× Ton-That, D. et al. (1977) T


He { 1s2s 3S --> 1s5d 3D }
×10-17
7.0
6.0
5.0
4.0
3.0
2.0
1.0
Cross section (cm2)
10⁰
10¹
10²
10³
10⁴
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T
× Ton-That, D. et al. (1977) T

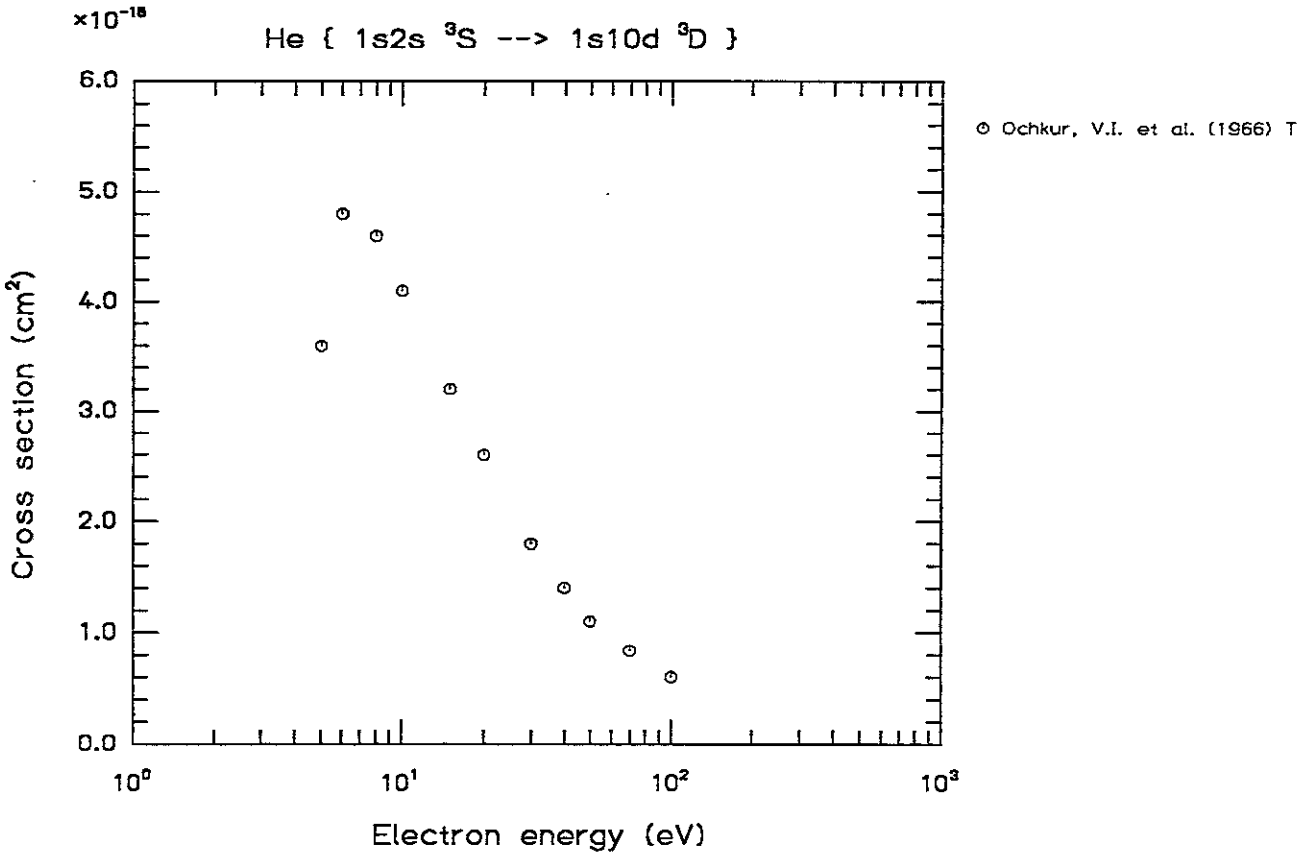

He { 1s2s 3S --> 1s5d 3D }
10-16
10-17
10-18
10-19
Cross section (cm2)
10⁰
10¹
10²
10³
10⁴
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T
× Ton-That, D. et al. (1977) T

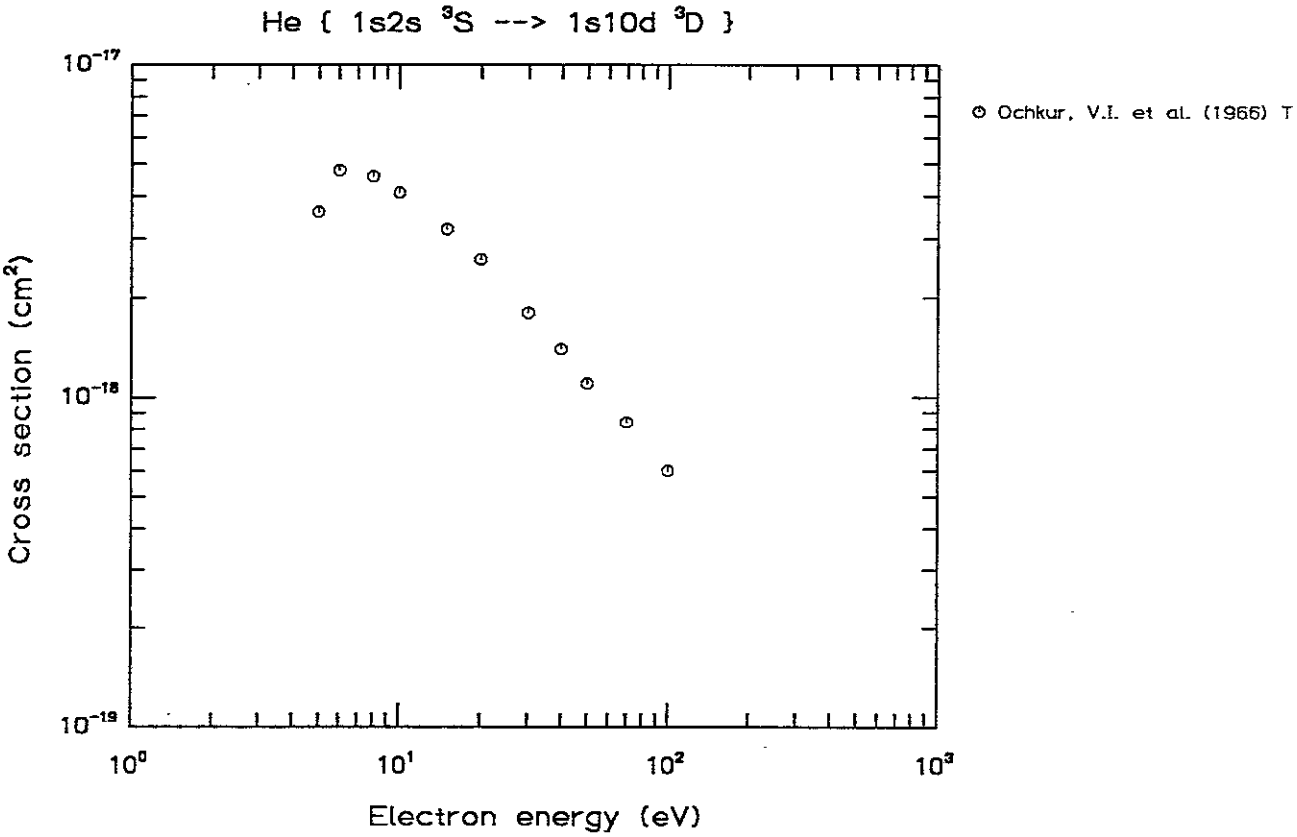


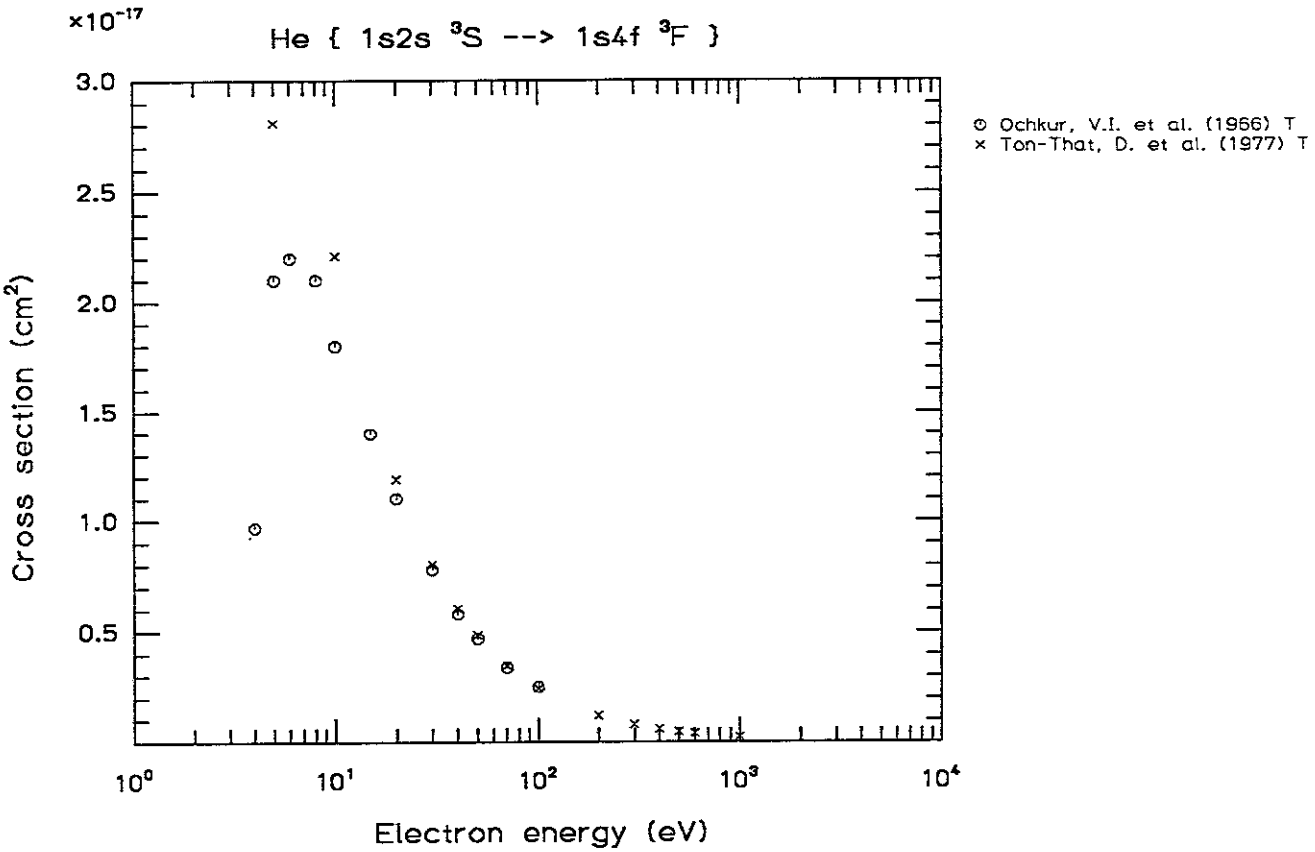

© Ochkur, V.I. et al. (1966) T

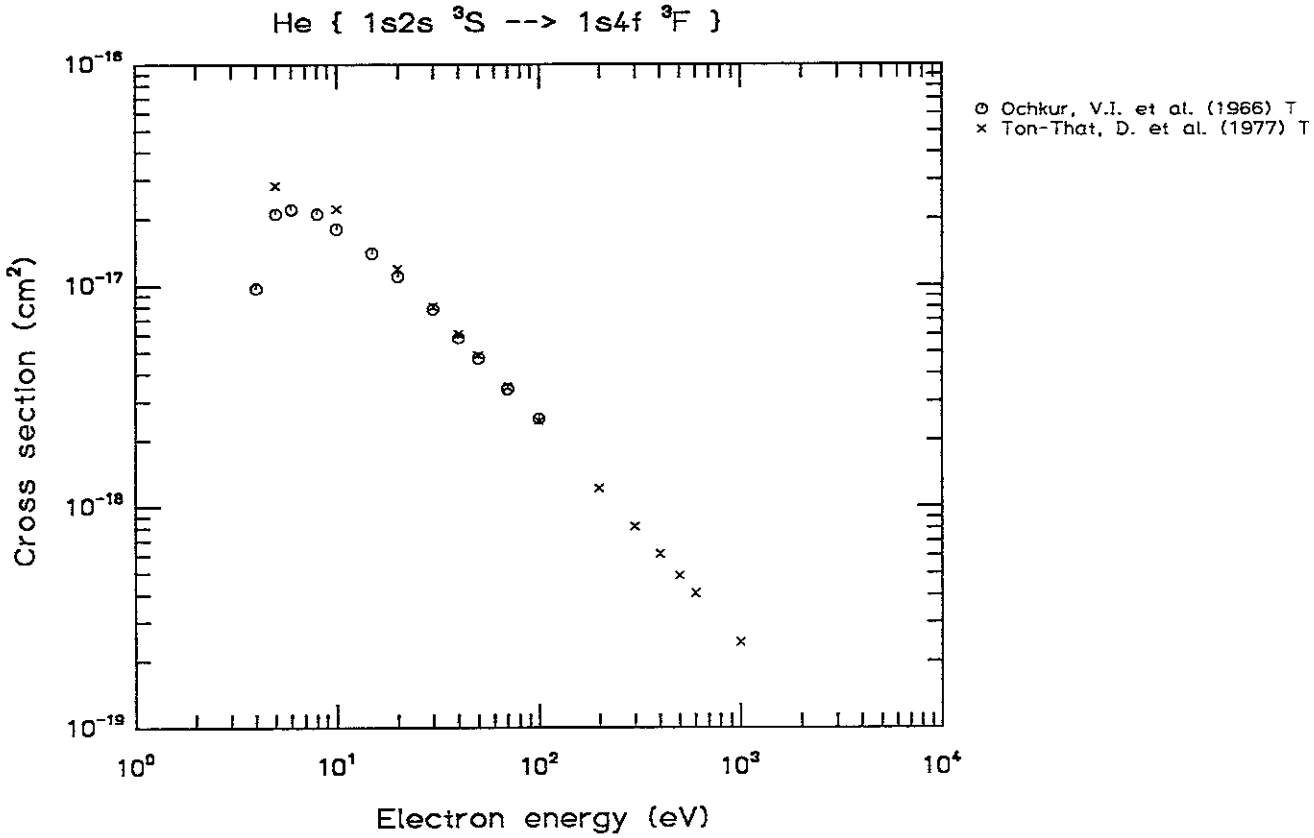


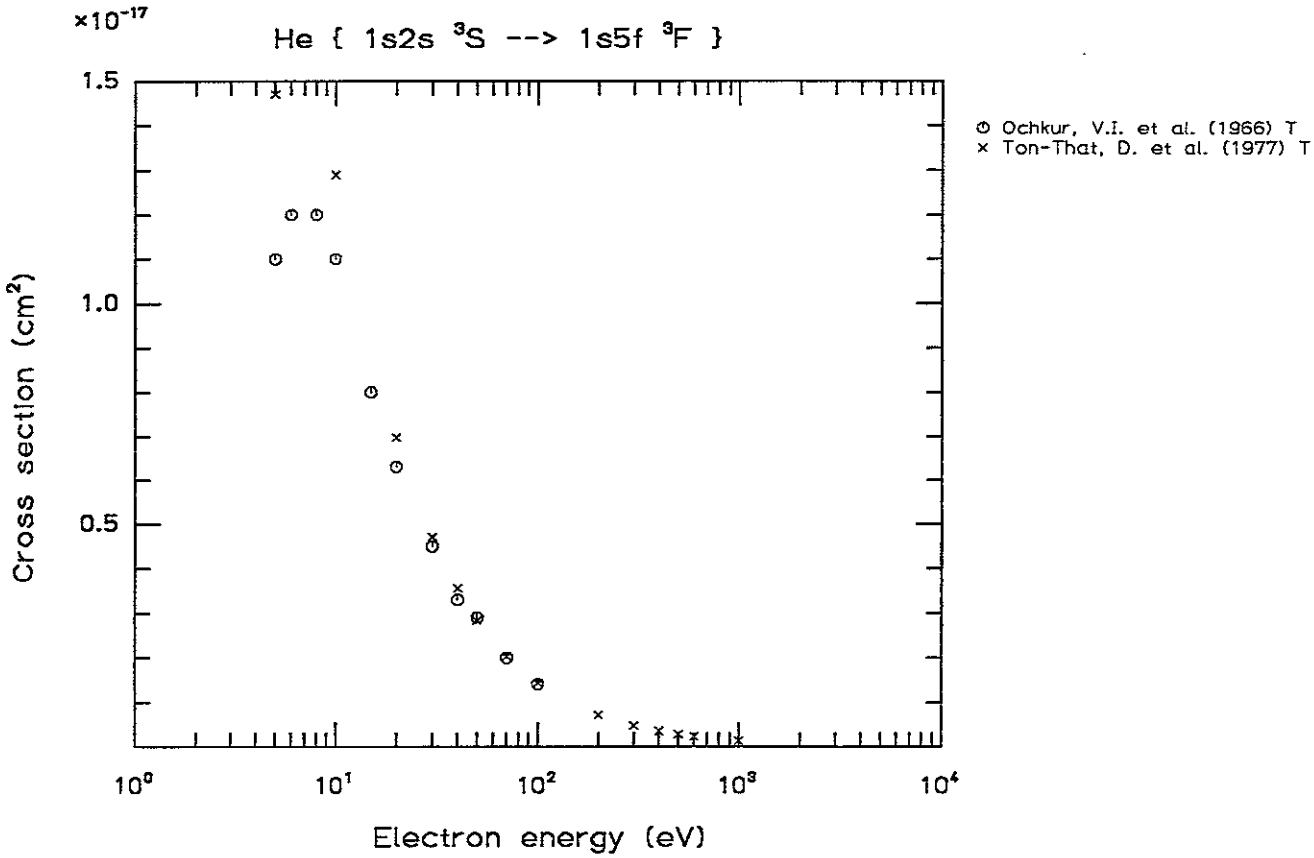

© Ochkur, V.I. et al. (1966) T

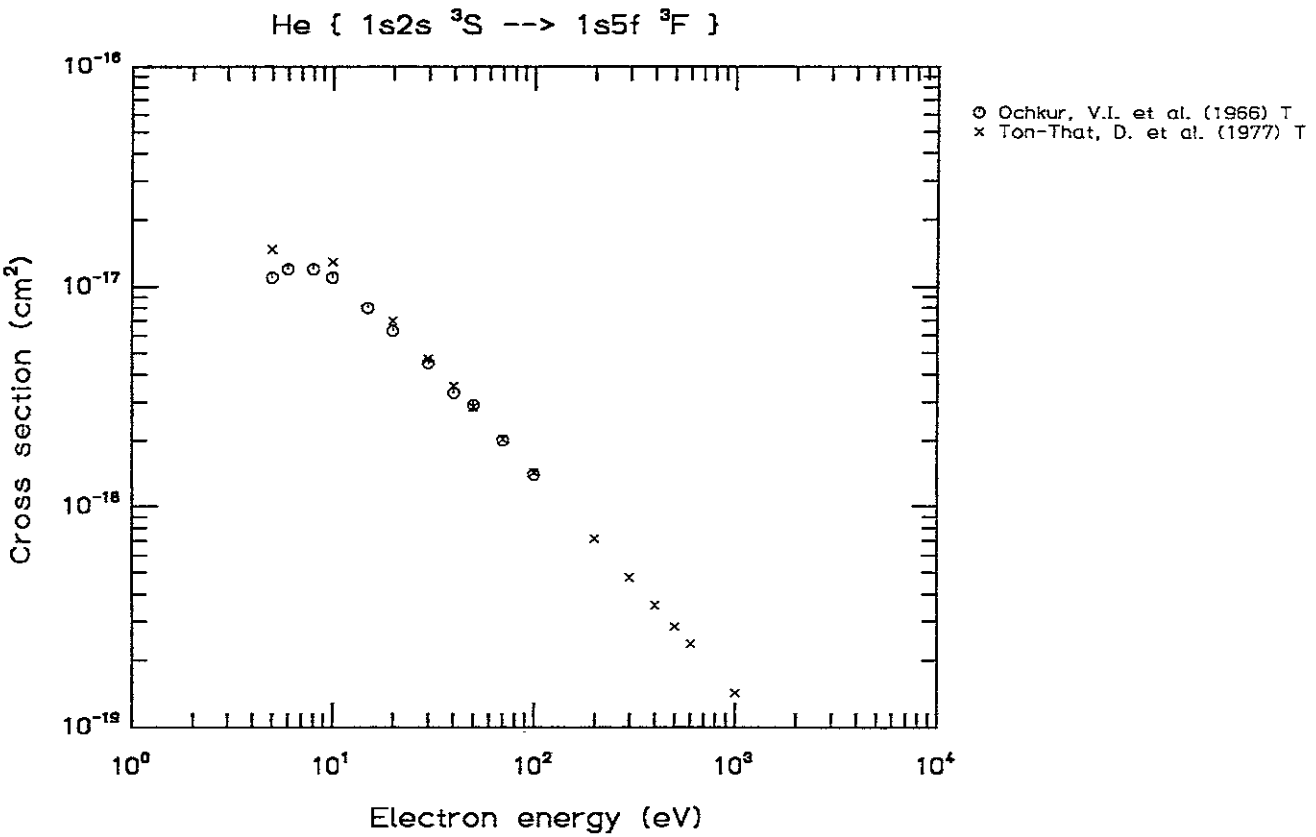

He { 1s2s 3S --> 1s10d 3D }
×10⁻¹⁸
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Cross section (cm²)
10⁰
10¹
10²
10³
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T

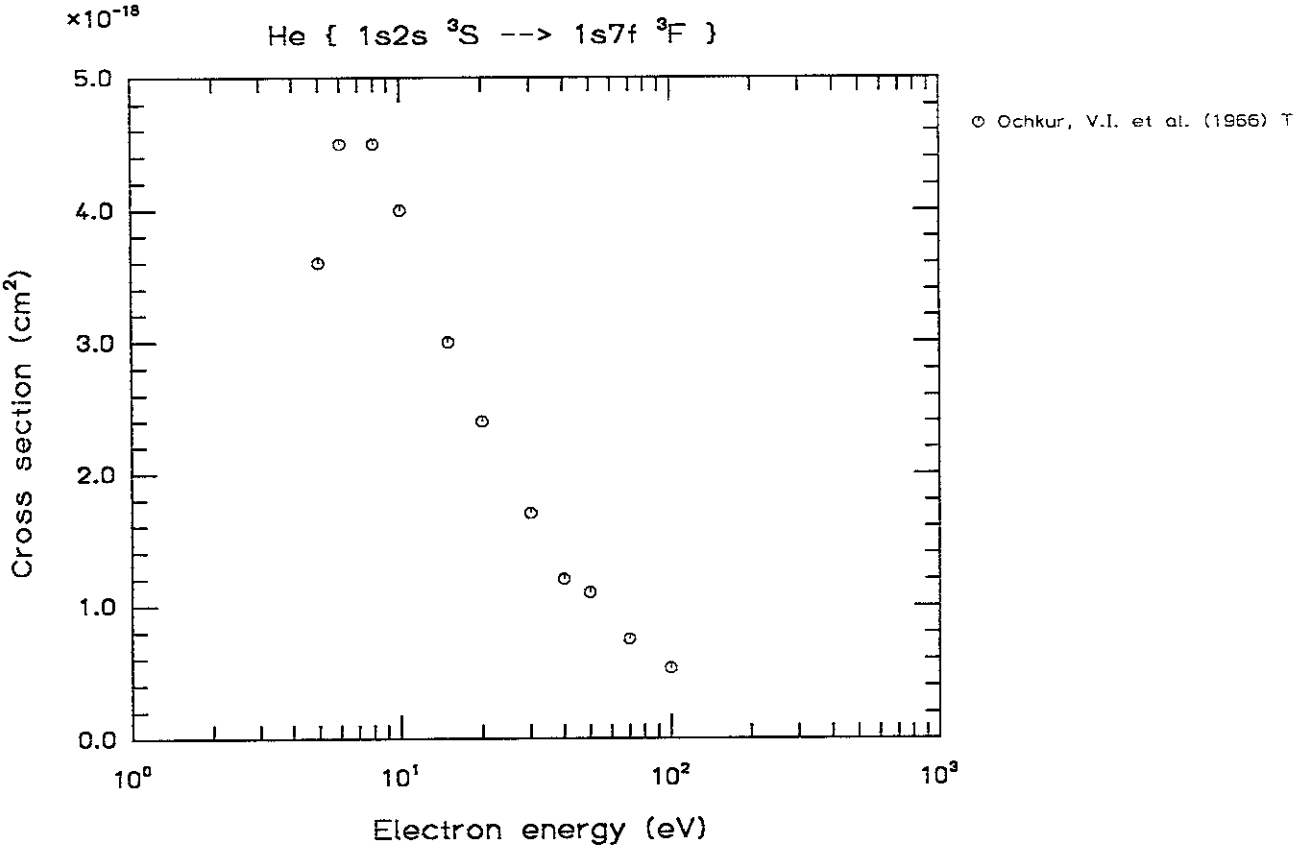

He { 1s2s 3S --> 1s10d 3D }
10⁻¹⁷
10⁻¹⁸
10⁻¹⁹
Cross section (cm²)
10⁰
10¹
10²
10³
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T

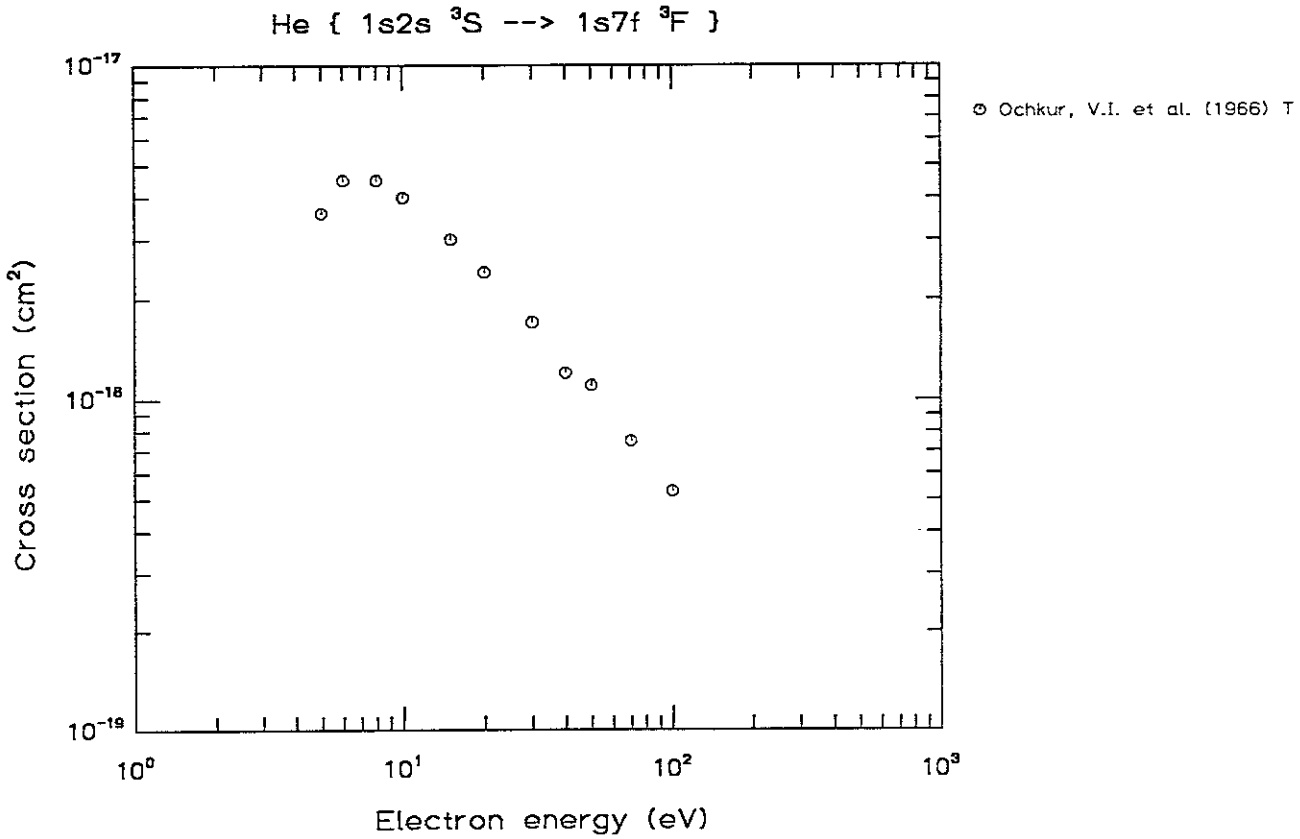

He { 1s2s 3S --> 1s4f 3F }
×10-17
3.0
2.5
2.0
1.5
1.0
0.5
Cross section (cm2)
10^0
10^1
10^2
10^3
10^4
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T
× Ton-That, D. et al. (1977) T

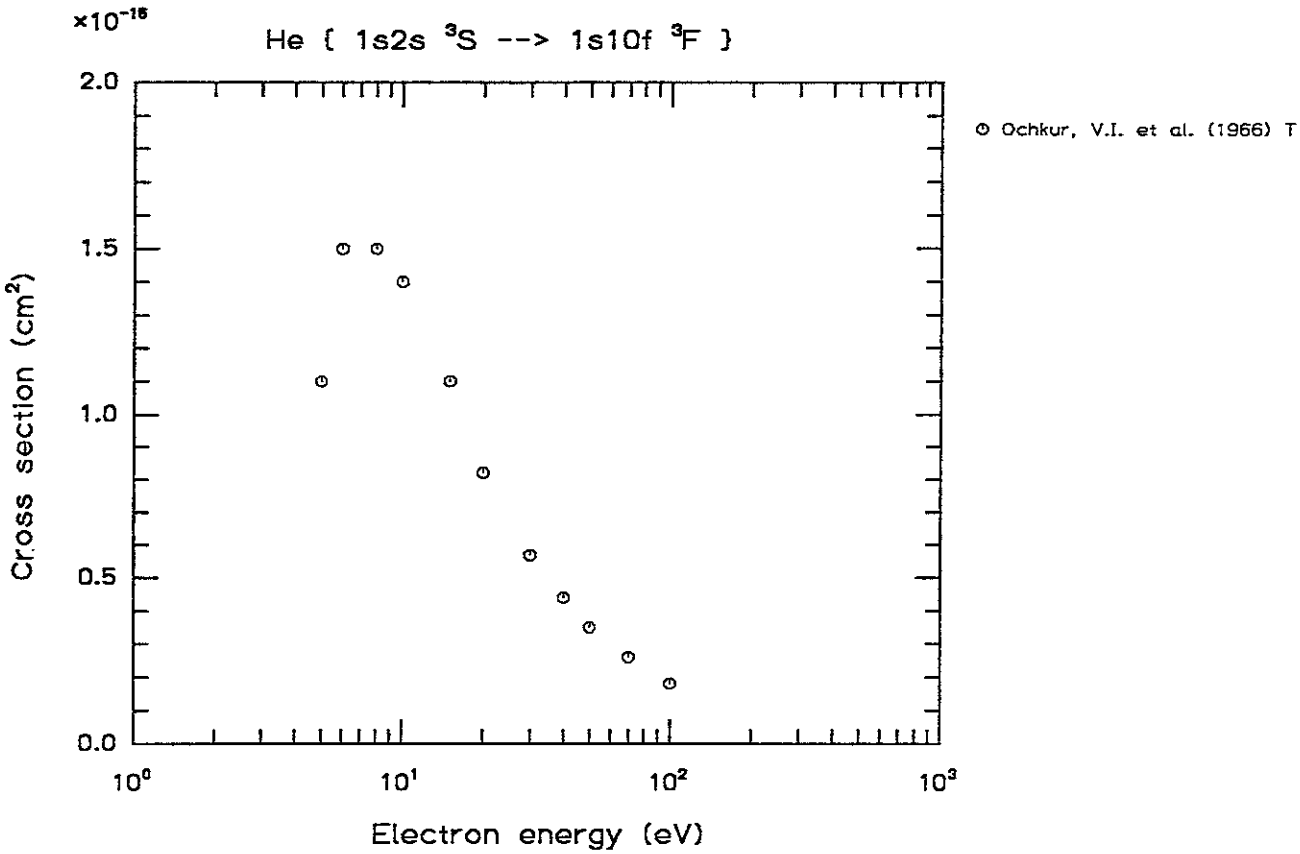

He { 1s2s 3S --> 1s4f 3F }
10-16
10-17
10-18
10-19
Cross section (cm2)
10^0
10^1
10^2
10^3
10^4
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T
× Ton-That, D. et al. (1977) T

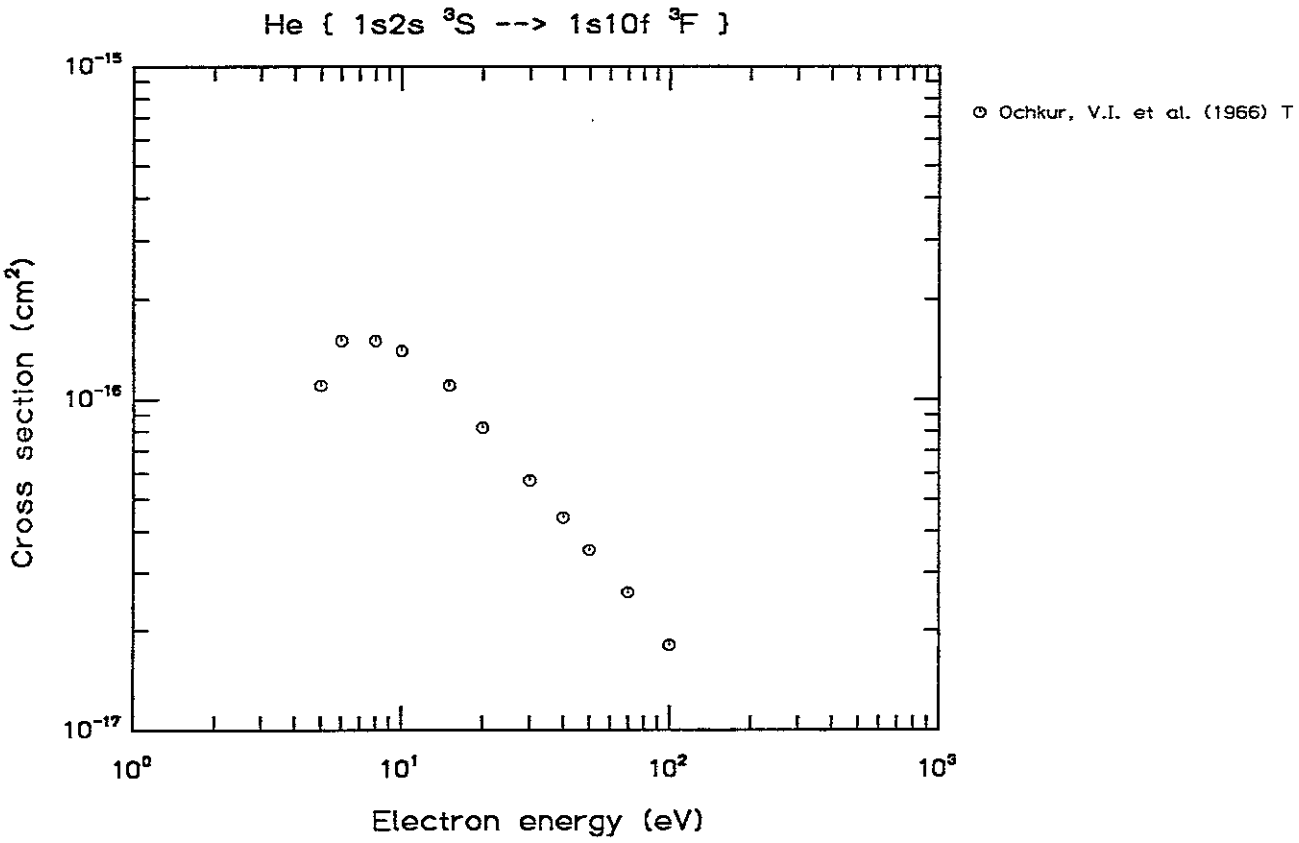

He { 1s2s 3S --> 1s5f 3F }
×10-17
1.5
1.0
0.5
Cross section (cm2)
10⁰
10¹
10²
10³
10⁴
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T
× Ton-That, D. et al. (1977) T

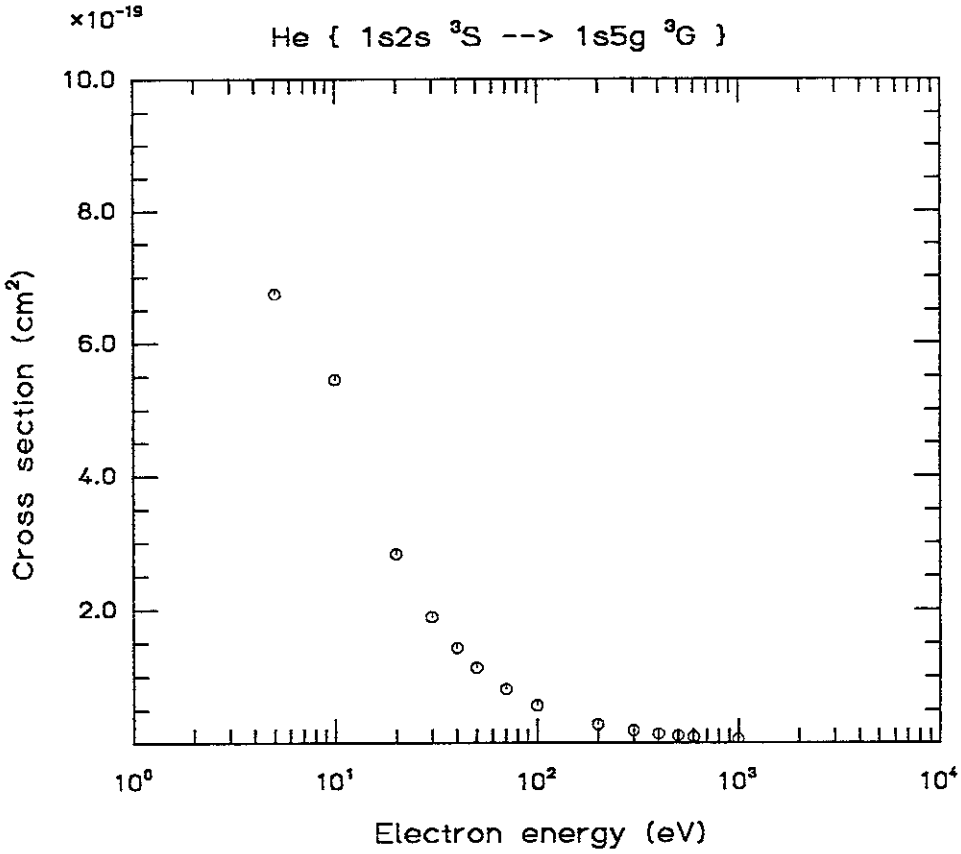

He { 1s2s 3S --> 1s5f 3F }
10-16
10-17
10-18
10-19
Cross section (cm2)
10⁰
10¹
10²
10³
10⁴
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T
× Ton-That, D. et al. (1977) T


He { 1s2s 3S --> 1s7f 3F }
×10-18
5.0
4.0
3.0
2.0
1.0
0.0
Cross section (cm2)
10^0
10^1
10^2
10^3
Electron energy (eV)
Ochkur, V.I. et al. (1966) T

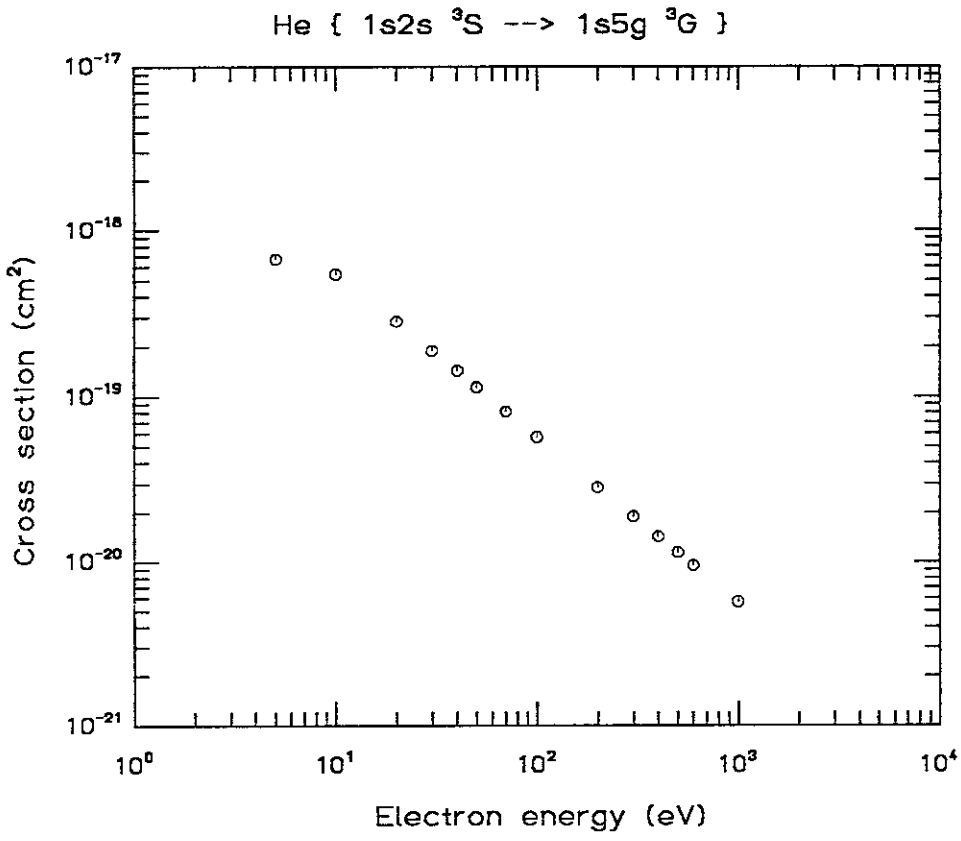

He { 1s2s 3S --> 1s7f 3F }
10-17
10-18
10-19
Cross section (cm2)
10^0
10^1
10^2
10^3
Electron energy (eV)
Ochkur, V.I. et al. (1966) T


He { 1s2s 3S --> 1s10f 3F }
×10⁻¹⁵
2.0
1.5
1.0
0.5
0.0
Cross section (cm²)
10⁰
10¹
10²
10³
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T

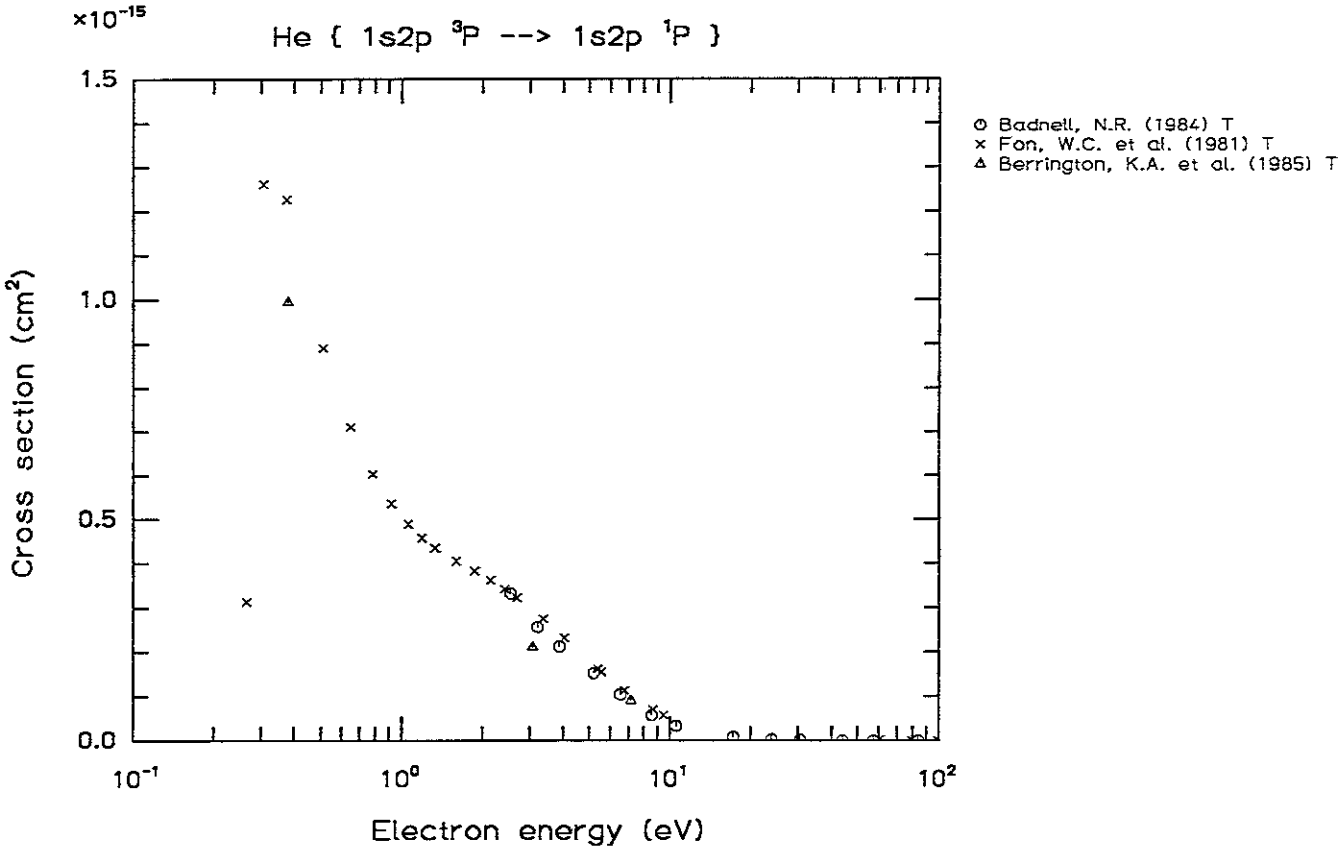

He { 1s2s 3S --> 1s10f 3F }
10⁻¹⁵
10⁻¹⁶
10⁻¹⁷
Cross section (cm²)
10⁰
10¹
10²
10³
Electron energy (eV)
⊙ Ochkur, V.I. et al. (1966) T

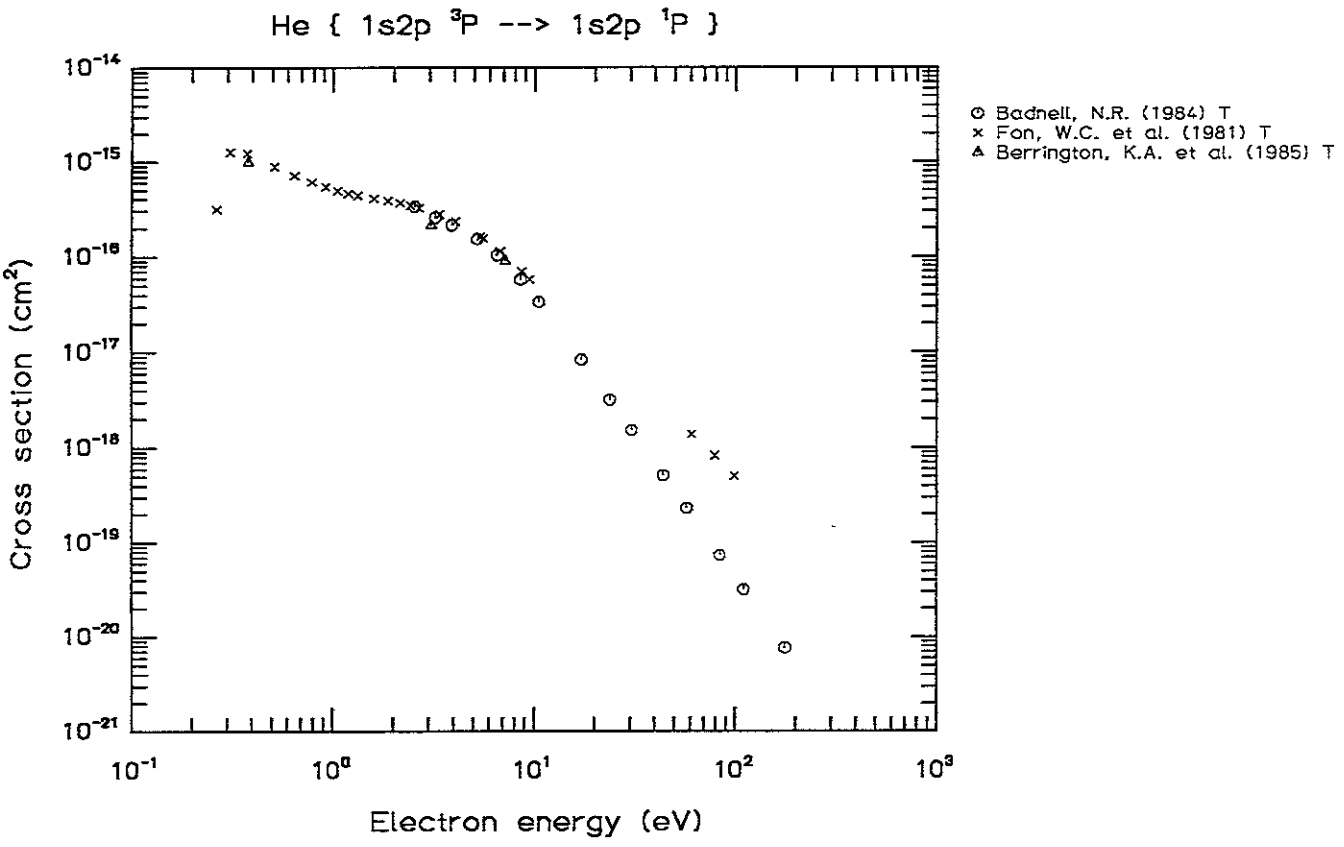



⊙ Ton-That, D. et al. (1977) T




⊙ Ton-That, D. et al. (1977) T


He { 1s2p 3P --> 1s2p 1P }
×10-15
1.5
1.0
0.5
0.0
Cross section (cm2)
10-1
100
101
102
Electron energy (eV)
⊙ Badnell, N.R. (1984) T
× Fon, W.C. et al. (1981) T
△ Berrington, K.A. et al. (1985) T


He { 1s2p 3P --> 1s2p 1P }
10-14
10-15
10-16
10-17
10-18
10-19
10-20
10-21
Cross section (cm2)
10-1
100
101
102
103
Electron energy (eV)
⊙ Badnell, N.R. (1984) T
× Fon, W.C. et al. (1981) T
△ Berrington, K.A. et al. (1985) T

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