§5. 3D Monte Carlo Simulation for H-alpha Spectra Observed in Compact Helical Systems

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In the previous study[1], DEGAS neutral transport simulation code (ver.63) has already been applied to complicated edge region of Compact Helical System (CHS) and given us neutral particle information. DEGAS also contains the routine to treat various H-alpha emission processes, and spectra profile to be compared with experimental data is also obtained. However, information on edge plasma parameters is practically insufficient in CHS and appropriates assumptions are made for 3-D simulation and simulation models themselves must be improved with observation data.

In this work, we include the detector information into mesh model data for CHS, and calculate H-alpha chordal intensity and spectra. In CHS standard magnetic configuration, neutral sources is localized poloidally and toroidally and visible detector is located near one of them. So in order to improve toroidal mesh resolution, model geometry is changed from full tours to a quarter sector[2], and effect of chamber wall shape is also examined. Simulation domain is restricted to a quarter sector of a torus and divided to 40 zones like Fig.1. Toroidal domain is from $\phi = -22.5$[deg.] to $\phi = 67.5$[deg.]. Since CHS helical coils have toroidal periodicity of $m = 8$, this domain corresponds to two toroidal pitches. Toroidal boundary at $\phi = -22.5$[deg.] and $\phi = 67.5$[deg.] is set as "Warp" boundary. A particle which crossed $\phi = -22.5$[deg.] section is moved artificially to another boundary at $\phi = 67.5$[deg.] and reinjected so as to keep relative velocity direction with the helical structure of chamber and LCFS.

Figure 2 compares hydrogen molecular density contours for no duct section ($\phi = 45$[deg.], Fig. 2(a)) and duct section ($\phi = 0$[deg.], Fig. 2(b)). As neutral particles entering into core plasma are soon ionized and can not move long distance, their toroidal transport through the gap between chamber wall and core plasma determines the neutral density profile. If a viewing port duct is included, there might exist leakage of neutrals toward the viewing port. In fact, poloidal transport of hydrogen molecules is a little enhanced and their contribution to H alpha emission also increases due to this geometrical effect.

Many pathways generating H($n = 3$) have contributions to H alpha spectra. By summing up of all pathway contribution, H alpha spectra shape is obtained. One example for center sight line is shown in Fig.3. Global shape of calculated spectrum well agrees with experimental data for this this sight line ($R_{det} = 97$[cm]).

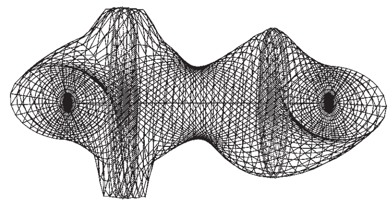
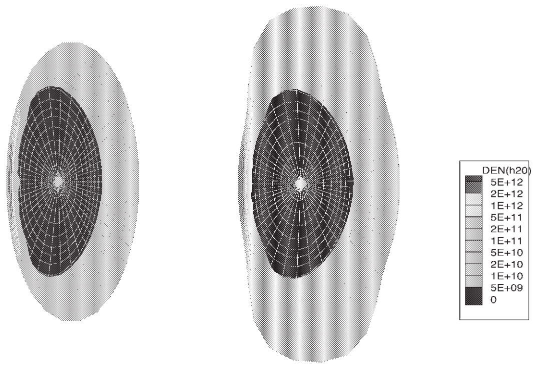


Fig. 1: Calculation geometry for the DEGAS simulation. Core plasma and vacuum region is divided into $45 \times 13 \times 40$ zones.



(a) No duct section

(b) Duct section

Fig. 2: Hydrogen molecular density on no duct section and duct section for standard configuration of CHS.

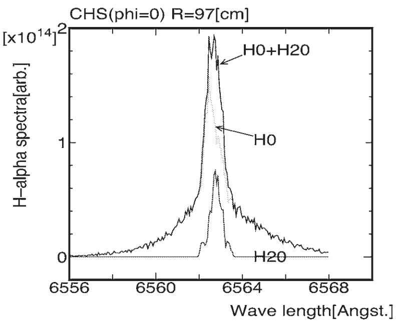


Fig. 3: H alpha spectrum for CHS center sight line at $R_{det} = 97$ [cm]. Three lines show contributions from atom, molecule, and their summation.

1) H.Matsuura et al.: J. Nucl. Mater. **363-365** (2007) 806.

2) M.Shoji et al.: J. Nucl. Mater. **313-316** (2003) 614.