§3. Characteristics of Single Slanted Cusp-DEC

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In order to study the performance of a cusp DEC, we investigate characteristics of a single slanted cusp, which might be better than a conventional vertical cusp from the view point of separation of electrons from ions. One of the indices for the separation is a Störmer region [1], Fig.1, where the radii of the inlet and outlet circular cusp coils are R_0 and 1.5 R_0 and axial positions are - R_0 and R_0, respectively, where R_0 is the normalized radius. The numbers in Fig.1 indicate the Störmer potential ($V_{st}(r,z) = [P\theta - q_j\psi(r,z)]^2 / 2m_j r^2$, where P = canonical angular momentum and ψ = flux function) normalized by $m_p v_n^2 / 2$, where v_n = $_0 I_{in}\, e /$ m_p, I_{in} = current of an inlet coil, and m_p = proton mass. The stagnation point ($\partial V_{st}(r,z)/\partial r = \partial V_{st}(r,z)/\partial z = 0$) of the Störmer potential gives classification between trapped charged particles in a line cusp region and those which are passed through a single cusp field to a point cusp region. The effects of slant of cusp magnetic field lines is shown in Fig.2, where the Störmer potential at the stagnation is presented as s function of the current ratio of the outlet magnetic coil to the inlet, where the normalized P by $m_e R_0 v_n$ equals to 10.0 as an example and the coil arrangement is the same as Fig.1. As the increase of the outlet coil current, which corresponds to the strong slant of the magnetic field lines, the Störmer potential at the stagnation point increased almost proportionally to the current ratio.

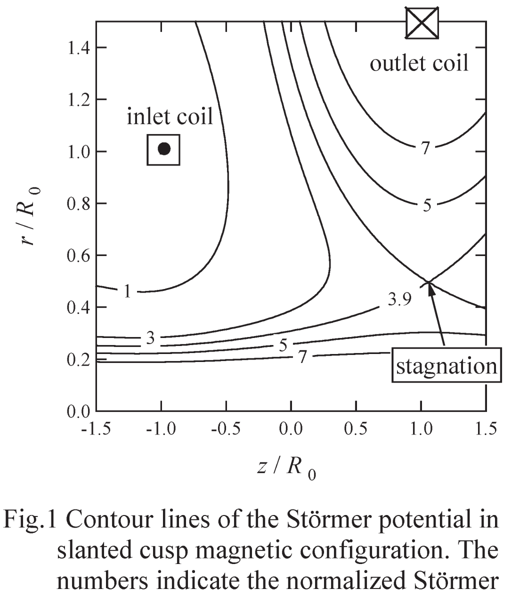

Fig.1 Contour lines of the Störmer potential in the slanted cusp magnetic configuration. The numbers indicate the normalized Störmer potential.

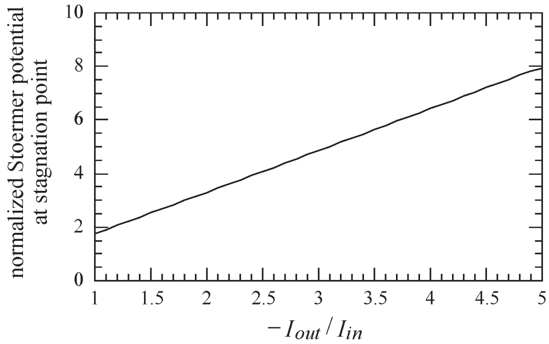

Fig.2 Störmer potential at the stagnation as a function of the current ratio of the outlet cusp magnetic coil to the inlet, where the notmalized P is 10.0 and the coil arrangement is the same as Fig.1.

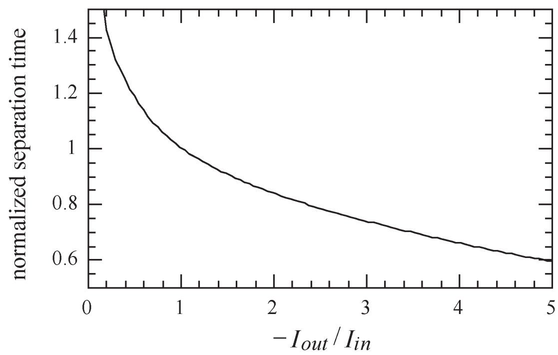

Fig.3 Separation time normalized by that of I_{in} = - I_{out} as a function of current ratio. Here the separation time is defined by the time when distance between an electron and an ion is $R_0/2$. The coil arrangement is the same as Fig.1.

The stronger slant of magnetic field lines separates effectively charged particles with lower energy like electrons from those with high energy like ions, where the electrons are guided to the line cusp region and ions are led to the point cusp region. In order to confirm this effect, the separation time between an electron and an ion is calculated by tracing their orbits. Initially these particles are injected from the inlet coil region (r, z) = ($0.5R_0$, - $1.5R_0$) with the same axial velocity. Here the separation time is defined by the time when the distance between an electron and an ion is $R_0/2$. The separation time normalized by that of I_{in} = - I_{out} is shown in Fig.3. One can see the stronger slant makes the short separation time, which might be better for effective separation. As the electrons are mirror-trapped in the line cusp region, the early removal of electrons might be one of the ways to get good separation. These results mean the stronger slanted cusp configuration has a possibility of effective separation of electrons and ions.

Reference

1) W. Schuurman and H. de Kluiver, Plasma Phys., **7**, (1965) 245.