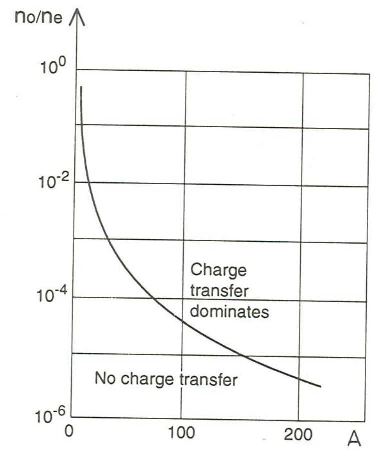

Figure 1.4.23 Golovanivsky's boundary conditions under which charge transfer dominates or has little effect [103].

of the ion energy. An even simpler expression was derived from Chibisov's formula; though less accurate, it still provides the order of magnitude [108]

$$K = 1 \quad \sigma_x = 1.7 \times 10^{-15} z \quad (\mathrm{cm}^2). \tag{1.4.42}$$

For the allowable limit of the neutral density in ECRIS we suppose that the time of charge transfer τ_x limits the lifetime of a cold ion at charge state z. We then write (supposing $T_i \sim 1$ eV, i.e. $v_i \sim 10^8/\sqrt{A}\,\mathrm{cm\,s^{-1}}$,

$$\tau_{z \to z-1} = [n_0 v_i \sigma_x]^{-1} \sim 5 \times 10^8 \sqrt{A}/z n_0 \tag{1.4.43}$$

where $n_0\,(\mathrm{cm}^{-3})$, is the density of neutral atoms and A is the atomic mass number. To attain the charge state z it is necessary that τ_x be greater than the ionization time for the same z (for the given electron density). This condition, along with $n_e \tau_i \sim 5 \times 10^4 \xi^{-1} (T_e)^{3/2}$ yield the upper limit of the allowable concentration of neutral atoms in the plasma for a given electron density n_e.

$$n_0/n_e \leqslant 7 \times 10^3 \xi [T_e^{opt}]^{-3/2} A^{1/2} z^{-1}. \tag{1.4.44}$$

The dependence of n_0/n_e on A for ionization of hydrogen-like ions to bare nuclei is shown in figure 1.4.23 [103]. We see that charge transfer imposes

→ boundary

1.5 MOTIONS OF CHARGED PARTICLES

1.5.1 The possibility of describing individual magnetoplasma

We have seen in section 1.3 that in a true plas Debye sphere) the particle motion is ascribable to to collective interactions represented by electric f of the order of the Debye length. The dominance interactions over short-range two-body interact individual particle motion in electric and magneti dimensions are large with respect to the Debye leng that turbulence does not randomize the motion. allowed to drift freely under the action of cohere also recognize that some of these E fields are poss or temperature gradients inside the plasma. Coher to propagate inside the plasma. They act on the pa cyclotron resonance. In all these cases and for all starting equation of motion for a charged particle field is given by the Lorentz force:

$$m\ddot{\boldsymbol{r}} = \boldsymbol{F} = e\,(\boldsymbol{E} + \dot{\boldsymbol{r}} \times$$

Many useful insights into the properties of ECR from a study of the motion of individual non-in and magnetic fields. However, first of all, we m of motion is linear (i.e. that $\boldsymbol{B}$ does not depend assumption allows the net particle motion to be rep of particle motions that correspond to the simpler

1.5.2 Gyromotion and drifts

1.5.2.1 Gyrofrequency and gyroradius. Conside uniform, constant $\boldsymbol{B}$ directed along the z-axis ($\boldsymbol{B}$ system and $\boldsymbol{E} = 0$. Taking the scalar product of $\ddot{r}$