GRAVITATIONAL INTERACTION OF STARS AND ISM: IMPLICATIONS FOR THE DISTRIBUTION FUNCTION

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The stellar system and the ISM are coupled to each other by their common gravitational field. Since the point-like structure of the individual, randomly moving stars represents a permanent perturbation of the gravitational potential, collective reactive modes are generated in the stellar as well as in the gaseous component [2, 4]. Thus the evolution of the distribution function of the stars is determined by pure stellar encounters as well as by interactions with collective modes. Using fluctuation theory in quasilinear approximation we derive a Fokker-Planck-equation including both effects [1, 3]:

$$\frac{\partial\langle f\rangle}{\partial t} = div_v\Big([D^{point}(v) + D^{collec}(v)]\{\frac{\sigma^2}{2}\nabla_v\langle f\rangle + \vec{v}\langle f\rangle\} + \vec{v}R(v)\langle f\rangle\Big)$$

where D^{point} describes pure stellar encounters and D^{collec} describes the interaction with collective modes. For a Gaussian velocity distribution, the expression in the curved brackets vanishes. Hence collective modes - induced by the point-like structure of the stars - give rise to an enhanced relaxation towards a Gaussian velocity distribution. The individual stars suffer an additional dynamical friction with the ambient gas represented by $R(v)$. R is very small for subsonic velocities but exhibits a sharp increase near the sound speed c_s. For $v > c_s$ it is $R \propto v^{-3}$. The contribution to D^{collec} arising from collective modes of the gas has the same v-dependence as $R(v)$, the respective amplitudes, however, depend in different ways on the large-scale parameters of the system. In the case that the friction time scale is smaller than the relaxation time scale, the velocity distribution may considerably deviate from a Gaussian shape. The general consequence of the additional friction leads to a 'cooling' of the stellar component [Just et al., this volume]. For example, newly formed stellar clusters may 'cool down' within their parental molecular cloud till $\sigma < c_s$. We find the respective time scale to be of the order of some $10^6 yr$.

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