DYNAMICAL BEHAVIOUR OF GASEOUS HALO IN A DISK GALAXY

S. Ikeuchi and A. Habe
Department of Physics, Hokkaido University,
Sapporo 060, Japan

Assuming that the gas in the halo of a disk galaxy is supplied from the disk as a hot gas, we have studied its dynamical and thermal behaviour by means of a time dependent, two-dimensional hydrodynamic code.

We suppose the following boundary conditions at the disk. (i) The hot gas with the temperature T_d and the density n_d is uniform at r=4 - 12 kpc in the disk and it is time-independent. (ii) This hot gas rotates with the stellar disk in the same velocity. (iii) This hot gas can escape freely from the disk to the halo. These conditions will be verified if the filling factor of hot gas is so large as f=0.5-0.8, as proposed by McKee and Ostriker (1977).

These models have already been examined by Bregman (1979, 1980). In the present paper, we have studied the gas motion in the halo for wider ranges of gas temperature and its density at the disk than those studied by Bregman (1979, 1980). At the same time, we have clarified the observability of various types of gaseous haloes and discuss the roles of gaseous halo on the evolution of galaxies.

Depending upon the values of T_d and n_d, the resultant gaseous halo can be classified into three types, i. e., (a) a wind type, (b) a bound type and (c) a cooled type. This is shown in the Figure.

In the wind-type halo, the gas expands with the velocity higher than the escape velocity, sometime with the supersonic velocity, and the radiative cooling hardly affects the gas motion. This wind-type halo is realized when $T_d \gtrsim (2-4) \times 10^6$ K and $n_d \lesssim 10^{-2}$ cm^{-3}. The gas temperature in the halo exceeds $\sim 1 \times 10^6$ K, and its density below $z \sim 4$ kpc is larger than 10^{-4} cm^{-3}. The isointensity curves at E_x=0.28-0.53 keV become parallel to the disk plane, and the region $r \lesssim 10$ kpc and $z \lesssim 2$ kpc is brighter than 10^{-7} erg cm^{-2} s^{-1}. The total X-ray luminosity at E_x=0.4-4 keV is 10^{37-39} erg s^{-1}.

The cooled type of gaseous halo is formed if $T_d \lesssim 10^6$ K or $n_d \gtrsim 10^{-2}$

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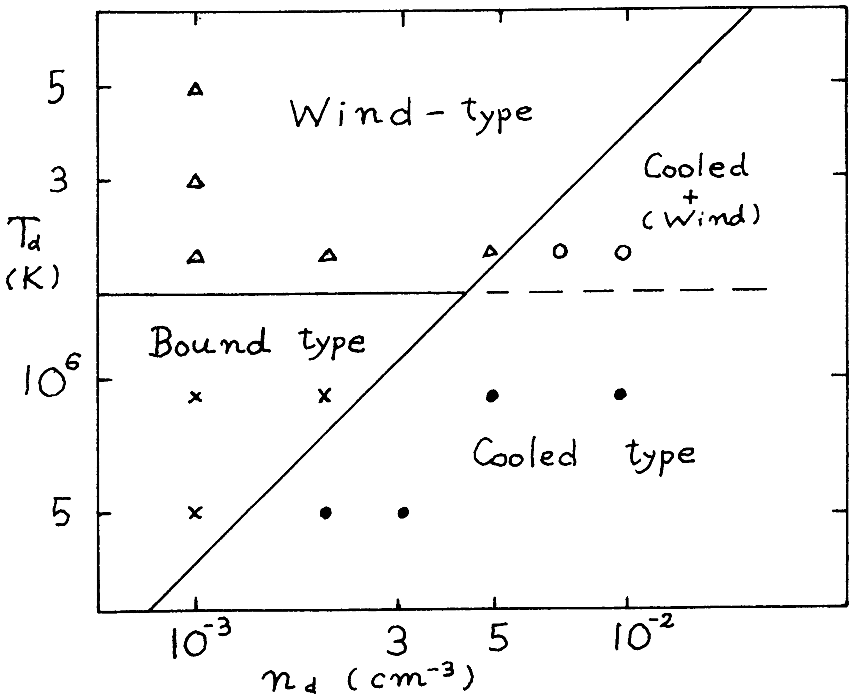

cm^{-3}. Two distinct flow patterns are realized, depending upon T_d and n_d. One is the case when $T_d \lesssim 10^6$ K and the radiative cooling is efficient within $t \lesssim 10^7$ y. Once the gas expands to the halo, it collapses to the disk due to rapid cooling as a whole. Because of centrifugal force, the gas is trasferred to the outer region of the disk and falls with the velocity 30-70 km s^{-1}. On the other hand, when $T_d \gtrsim (2-4) \times 10^6$ K but $n_d \gtrsim 10^{-2}$ cm^{-3}, the gas initially expands extensively and a part of the gas escapes from the galaxy as a wind. However, the radiative cooling is efficient for the disk gas within $r \lesssim 8$ kpc and it falls to the outer region of the disk after rapid expansion. Since the falling gas and the outflowing gas encounter at the region r= 6-12 kpc and z=1-4 kpc, the compressed and then cooled gas extends there. These gas components may be observed as high velocity clouds because the falling velocity would attain $\gtrsim 100$ km s^{-1}.

If these characteristics of dynamical and thermal behaviours are observationally confirmed, the properties of hot gas in the disk would be clarified.

References

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