Properties of the interstellar gas clouds

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The characteristics of interstellar gas clouds play the main role in any theories of star formation. The dense molecular cloud cores are probably immediate parents of stars. However, the molecular clouds themselves arise obviously from some structures of atomic component of interstellar medium, because namely in the atomic gas may arise two-phase system: clouds and intercloud medium, namely neutral atomic clouds are able to increase their masses and densities due to inelastic collisions and rapid cooling. So the neutral atomic clouds may be named as "grand parents" of stars and their properties play genetic role for whole chain of matter transformations in the galaxies.

The RATAN-600 has greatly high sensitivity to low contrast details of emission observed on the bright complex background. That's why we were able to create the unique database of HI clouds on the base of HI RATAN-600 Survey. The angular resolution of this Survey was $2.4' \times 130'$, velocity resolution was 6.3 km/s, r.m.s. fluctuations of antenna temperature T_a was 0.25 K. All clouds with kinematical distances $r < 1.0$ kpc were rejected because their relative distance errors are very high. Moreover, clouds with $T_a < 0.75$ K (3 times r.m.s. errors) and line widths $\Delta V < 6.3$ km/s were rejected too. Diameters, masses, gas densities and velocity dispersions of about 7600 HI clouds were determined in the second and third quadrants of galactic longitudes in $180° < l < 260°$, $-15° < b < +15°$ $100° < l < 150°$, $-10° < b < +10°$. Some selection effects were discovered and our statistic results were corrected for them.

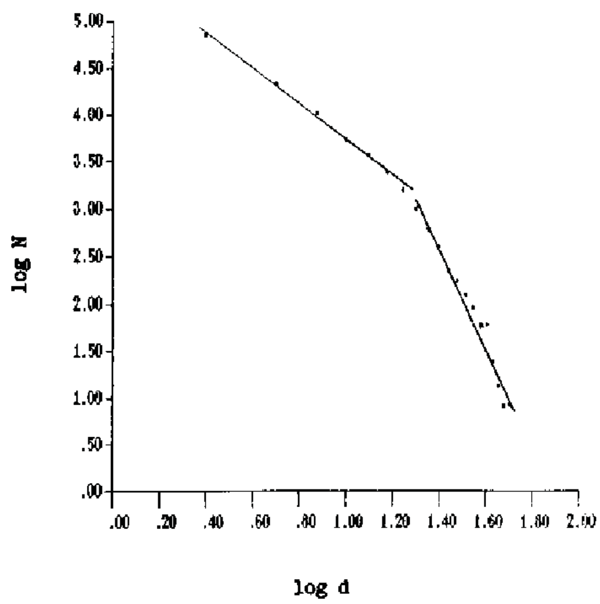

Fig. 1

It is found that mean clouds linear diameters along Galactic plane are 2.5 times greater than in transverse direction. The cloud diameter spectrum (Fig. 1) has a bimodal power shape with spectral indexes of –1.9 ± 0.5 between 1 – 16 pc, and –3.9 ± 0.5 between 16 – 45 pc.

HI gas density spectrum in the range of 1.0 to 300 cm^{-3} (Fig. 2) is not a power-law, but it has a maximum at n_H=10–40 cm^{-3} depending on galactic latitude. The lowest and highest densities observed in the clouds are very important parameters for theories of thermal instability and formation of molecules.

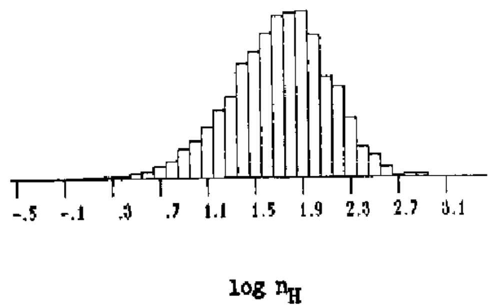

Fig. 2

The mass spectrum in the form of M·N(log M) was obtained in the mass range of 0.6 to 2.5·10^4 $M_\odot$ (Fig. 3). It consists of at least three parts. In the range of 2 to 600 $M_\odot$ the spectrum has a spectral index of 0.8 ± 0.1, in the range of 0.6 to 2 $M_\odot$ the spectral index is 3.0 ± 1, and in the range of 600 to 2·10^4 $M_\odot$ the spectral index is – 0.7 ± 0.3. These data show that the process of coalescence in cloud-cloud collisions predominates in the middle mass range but the clouds with low masses are evaporated probably due to very hot ISM component. In the very high mass range the number of neutral gas clouds may be decreased because of gravitational instability or/and molecularization.

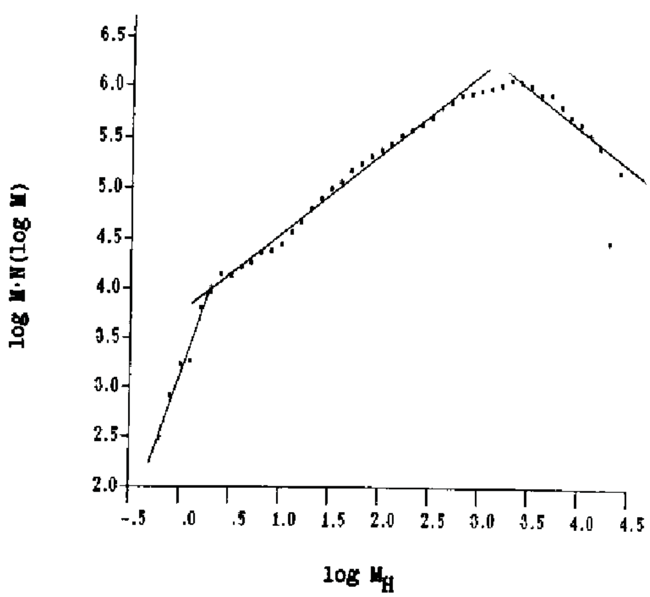

Fig. 3

The relation between HI concentrations and cloud diameters is confirmed in the form of $n_H \propto d^{-1.25 \, \pm \, 0.01}$ (Fig. 4) regardless of selection effects. The correlation coefficient between $log\ n_H$ and $log\ d$ is equal –0.87.

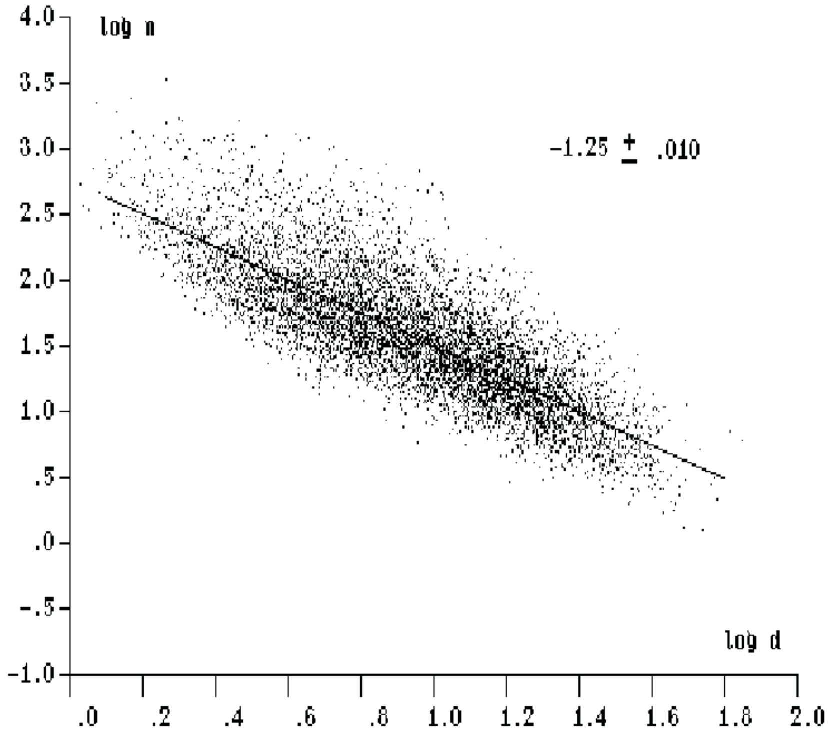

Fig. 4

It is shown that other important dependence, in particular velocity dispersion versus cloud diameters, that is well defined for molecular clouds, is completely absent in the case of HI clouds (Fig. 5). Probably this is due to negligible role of intrinsic turbulence in the HI clouds.

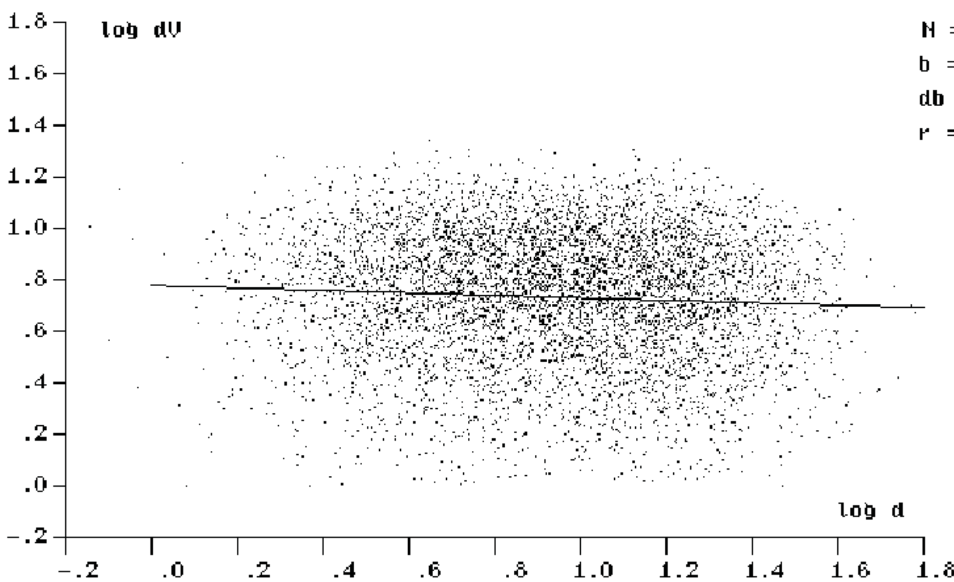

Fig. 5

It is found that 36% of HI clouds have systematic velocity gradients across cloud disks that is may be due to the rotation of clouds (Fig. 6). This phenomenon may explain rather high velocity widths of HI line profiles in the observable clouds. The mean value of clouds angular rotational velocity is about 10^{-13} s^{-1}, the mean rotational energy is about 10^{48} ergs, that is comparable to the energy of random cloud motions. Finally, observable quantities of clouds with opposite directions of rotation are equal within 5% in both galactic quadrants investigated.

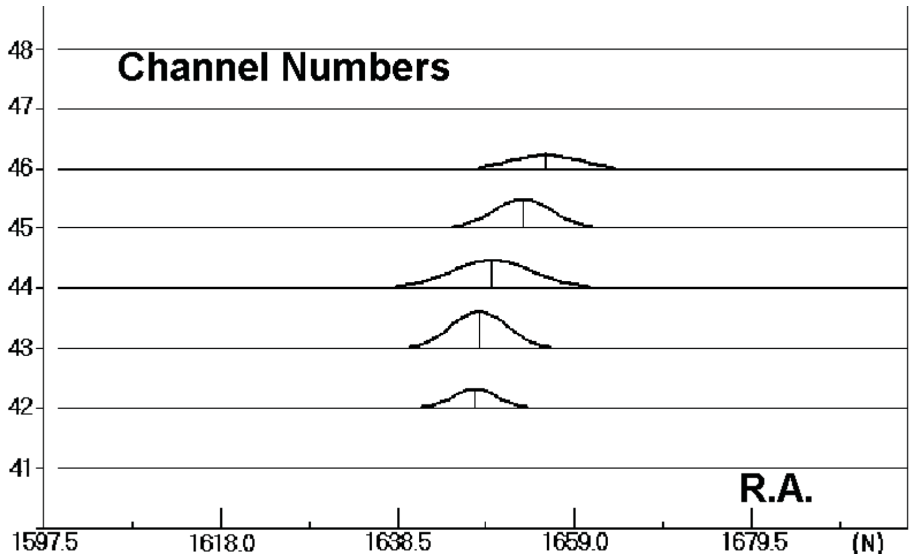

Fig. 6

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