THE HIGH LATITUDE CLOUD LYNDS 1642 IS NOT BREAKING UP

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ABSTRACT. CO, HCO^+ and NH_3 observations have been carried out towards the high latitude cloud L1642 using the 1.2-m GISS, the 11-m NRAO, the 14-m Metsähovi and the 100-m Effelsberg radio telescopes. The velocity field of the CO gas indicates a core-halo structure. The core component has a constant radial velocity, whereas the halo gas is slightly (< 1 km/s) redshifted, as compared to the radial velocity of the core, and shows velocity gradients towards the cloud edges in a similar way as the HI gas associated with L1642. Within the border of the ^{13}CO emission the mass of the cloud is estimated to be some $76M_{\odot}$. In contradiction to Magnani et al.(1985), who claimed that L1642 belongs to a population of very young high latitude clouds which are breaking up, this study supports the view that L1642 is in virial equilibrium and significantly older than 10^6 yr. The virial equilibrium of L1642 enables a distance determination of $\sim$ 190 pc to the cloud core.

1. SIGNS OF SHOCK INDUCED CLOUD IMPLOSION IN L1642

The Orion-Eridanus region contains large arc-like features, which clearly imply that supernova explosions have disturbed the interstellar medium. Due to the lower density of the medium at high galactic latitudes, disturbances can propagate to much larger distances as compared to the galactic disk. Thus it is natural to expect that shock fronts from supernovae of the Orion I OB association have passed also the 190 pc distant L1642 flattening the cloud in the direction of the arriving shock front and initiating a flow in the cloud envelope. It is also noteworthy that the extinction map of L1642 (Liljeström et al., 1988) shows pronounced dust "tongues" penetrating outwards from the cloud, a characteristic sign of Rayleigh-Taylor and Kelvin-Helmholtz instabilities.

These similarities with Woodward's model(1976) support an interpretation of a shock induced cloud implosion. Woodward's simulations predict also the formation of cloud condensations, some of which may be dense enough to undergo gravitational collapse. L1642 has produced two low-mass double stars. The more embedded one, associated with a CO outflow, is located in the outer part of the core region in a "tongue" structure.

E. Falgarone et al. (eds.), Fragmentation of Molecular Clouds and Star Formation, 454–455.

This is the predicted geometry and location for a new star in the model of Woodward (1976). The time for a shock driven low mass star formation is of the order 10^7 yr (Woodward, 1976) which is an order of magnitude longer than the dynamical time scale derived for high latitude clouds (Magnani et al., 1985).

2. DYNAMICAL STATE OF L1642 AND CORE DISTANCE

The virial theorem for a stationary cloud is $M(M_\odot) = C\,\sigma^2 R_{pc}$, where M is the cloud mass, R the effective cloud radius, C a constant depending on cloud geometry and density structure, and σ the 3-dimensional velocity dispersion. The best distance estimate to L1642, based on uvby and H_β photometry (Franco, 1989), is 114< r <230pc. Adopting a mean value, r = 170 pc, the virial masses of L1642 range from 50 to 97 $M_\odot$ when 4 different cloud models are considered. Comparing these with the observed M_{tot} = 75 $M_\odot$ (for r=170pc) it is obvious that L1642 is in virial equilibrium.

The virial equilibrium of L1642 enables a distance determination to the cloud core. From the virial theorem one obtaines

$$\sigma_{vir}(3\text{-dim}) = \sqrt{M(M_\odot)/C\,R_{pc}} = \sqrt{Ar_{pc}^2/C\,Dr_{pc}} \Leftrightarrow r_{pc} = \sigma^2\,C\,D/A \qquad (1)$$

where A and D are the numerical coefficients of r_{pc}^2 and r_{pc} in the observed cloud mass and effective cloud radius, respectively, and C the constant in the virial theorem. Substituting the numerical values obtained from the observations the most probable core distance of 190 pc is obtained, which is in accordance with the results of Franco (1989).

The line widths of ^{13}CO and even ^{12}CO have been commonly used to derive the velocity dispersion of a cloud. However, in addition that these line widths have not been corrected for opacity broadening, their use causes an observational selection bias towards the higher velocity dispersions of the envelope gas, which do not necessarily reflect the gas motions which oppose the gravitational collapse of a cloud. Especially it should be stressed that if systematic gas motions are included into the kinetic energy of a cloud (as e.g. Magnani et al. (1985) in L1642), the virial theorem of a bound and stationary system must be changed to

$$(1/t)\int_0^t (d/dt)\,\Sigma\,\vec{p}_j\cdot\vec{r}_j = 2 < E_{kin} > + < \Sigma\,\vec{F}_j\cdot\vec{r}_j > \qquad (2)$$

where $\vec{p}$ is the momentum vector, t the interaction time, and < > the symbol for time average. However, in this case the relation $\langle v^2\rangle = \overline{v^2}$ is not valid any more. Therefore, the velocity component of the halo gas should be examined carefully before it is included into virial theorem considerations.

REFERENCES

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