A STUDY OF THE KINEMATICS OF THE LOCAL DARK CLOUDS

by

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Declaration

I hereby declare that the work presented in this thesis is entirely original, and has been carried out by me at the Raman Research Institute under the auspices of the Department of Physics, Indian Institute of Science. I further declare that this has not formed the basis for the award of any degree, diploma, membership, associateship or similar title of any University or Institution.

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Thesis Overview

Lack of reliable estimates of distances to most of the local dark clouds has, so far, prevented a quantitative study of their kinematics. Using a statistical approach, we have been able to extract the average spatial distribution as well as the kinematical behaviour of the local dark clouds from their measured radial velocities. For this purpose, we have obtained radial velocities for 115 southern clouds and used the data from the literature for the northern ones. The thesis mainly deals with the presentation of this new data, analysis of the new as well as the existing data and the comparison of the results with those arrived at by earlier studies.

The local clouds are found to be expanding at a speed of ~ 4 kms^{-1} which is in general agreement with the estimates from optical and HI studies. However, it is found that the kinematics of the local clouds is not described by the model proposed for the local HI gas where a ring of gas expanding from a point gets only sheared by the galactic rotation. Rather, the observed distribution of their radial velocities is best understood in terms of a model in which the local clouds are participating in circular rotation appropriate to their present positions with a small expansion also super-imposed. This possibly implies that cloud-cloud collisions are important. The spatial distribution of clouds derived using such a model is in good agreement with the local dust distribution obtained from measurements of reddening and extinction towards nearby stars. In particular, a region of size $\sim$ 350pc in diameter enclosing the Sun is found to be devoid of clouds. Intriguingly, most clouds in the longitude range 100° to 145° appear to have negative radial velocities implying that they are approaching us.

Two other related research efforts are also reported in the thesis: (i) Since the clouds observed are distributed over the entire longitude range and wide latitude range, the resultant database of the spectral line parameters is well suited for studying the average physical properties of the local clouds. Our investigation in this regard shows that, with respect to latitude, the medians of both the brightness temperatures of the clouds and their ^{13}CO column densities increase marginally while the median of the ^{12}CO linewidths shows clear decrease. Some explanations for these trends are given. (ii) We also mapped one of the Orion system of cometary clouds, L1616, in $J=1\rightarrow 0$ transitions of ^{12}CO and ^{13}CO with a view to estimate its mass and star formation efficiency as well as to determine if it is gravitationally bound. It is found that the distribution of the emission in the line *wings* shows clear evidence for mass motions. Also, the *virial* mass of the cloud is found to be five times the actual cloud mass determined from the ^{13}CO column density map. It is argued that this cloud has abnormal star formation efficiency and is possibly disintegrating. The morphology and the location of the cloud indicates that it is being affected by the star ϵ Orionis which is also possibly responsible for the cloud's unusual star formation efficiency.

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They say: "Since men think that by the Knowledge of Brahman they become all, *what, pray, was it that Brahman knew by which It became all"*

This self was indeed the Brahman in the beginning. It knew itself only as "I am Brahman". And whoever among the gods had this enlightenment, also became Brahman. Now, if a man worships a deity, thinking: "He is one and I am another", he does not know. He is like an animal to the gods. As many animals serve a man, so does each man serve the gods. Even if one animal is taken away it causes anguish to the owner. Therefore it is not pleasing to the gods that men should know this.

-Brihadaranyaka Upanishad I.iv.9 & 10