ABSTRACT

Dark nebulae are dark, dense and cold cosmic clouds of gas and dust that contain a substantial fraction of the total mass of the interstellar medium. It is generally believed that stars are born out of these clouds by some mechanism as yet not fully understood. In some clouds like the Orion Nebula there is ample evidence for current star formation, while the situation for the smaller clouds like the Bok globules is far from clear. This thesis presents the results of a study of some aspects of dark nebulae in general and Bok globules in particular.

With an introduction in Chapter I, we discuss in Chapter II, the frequency distribution of cloud masses, by considering the statistics of dark clouds in our galaxy and also in some extragalactic systems. The existence of power law mass functions for dark clouds is shown, which is consistent with the Oort model for the formation and evolution of interstellar clouds. The mass distribution for clouds in the cloud-complexes is found to be different.

In Chapters III and IV we discuss some physical phenomena that could occur within or in the vicinity of a dark cloud in the galactic environment. In Chapter III we introduce the notion that radiation pressure could drive dust grains from
the interstellar medium into a Bok globule. Consequences of this process are worked out and it is shown that it will result in a dust density distribution in the globule that varies as the inverse cube of the radial distance from the globule centre. This is in excellent agreement with the observations of globules by Schmidt (1975) and Bok (1977). Chapter IV discusses the case of a spherical cloud of gas and dust where the dust grains gravitationally settle towards the centre. It is shown that the segregation of dust grains is size dependent and gives rise to a modification of the grain size distribution in the cloud as a function of time and radial distance from the centre. Expressions are derived for the modified grain size distribution function, average grain size and extinction as functions of distance from the cloud's centre and the age of the cloud. The mean grain size increases towards the centre of the cloud as does the extinction, while in the outer parts of the cloud they both decrease below their normal values. Results of the numerical evaluation of these quantities have been discussed with their implications for the observations of anomalous reddening and polarization within dark clouds and Bok globules.

In Chapter V are presented the results of the polarimetric observations of the Bok globule B 361 carried out in September 1982 in order to study the magnetic field geometry in the globule and to look for the effects of any grain segregation as discussed in Chapter IV. We found that the
magnetic field in the globule is roughly uniform, parallel to the N-S direction and makes an angle about 45° to the rotation axis of the globule. The inferred magnetic field strength in the globule is about 50 micro-gauss. The mean dust grain size in the outer parts of the globule is smaller than the normal interstellar grain size. This is consistent with the proposition made in Chapter IV that the larger grains have settled towards the globule centre thus leaving the mean grain size in the outer regions of the globule smaller.

Chapter VI deals with a piece of work on the binary X-ray pulsars. The pulse-period distribution of binary X-ray pulsars has been considered. A gap in this distribution, in the period range $P \sim 10$ s to $P \sim 100$ s has been explained in terms of the character of mass transfer in the X-ray binary systems. It is shown that this gap arises because the rotating magnetised neutron stars in these systems are slowed down by accretion torques, either to $P \lesssim 10$ s when the mass transfer is by mean of Roche-lobe overflow in low mass binaries, or to $P \gtrsim 100$ s by stellar winds in massive binaries. The gap is maintained as the slow pulsars ($P \gtrsim 100$ s) in their spin-up phase cross the gap in a time short compared to their life-time, because of the increase in mass transfer with the evolution of the normal star.