INTENSITY CHANGES IN SUNSPOTS AND STARSPOTS

The observations of sunspots have surprises to offer even to this day. A very elusive fact about sunspots is their relative brightness with respect to the undisturbed photosphere. Until recently, there have been conflicting reports regarding the presence of significant differences in the relative brightness of individual spots. The confusion existed because most of the observations were in the visual, where the scattered light caused a lot of uncertainties. However, the work of Ekmann and Maltby (*Sol. Phys.*, **35,** 317, 1974) in the near infrared clearly showed that there were significant differences in the darkness of individual spots. What turned out to be more interesting was that Albregtsen and Maltby (*Nature*, **274**, 41, 1978) were able to correlate the umbral intensity at 1.67 μm with epoch in the solar cycle. However, since the latitude of occurrence of sunspots changes with the epoch, they have tried a correlation with latitude as well. They did succeed but with a somewhat smaller correlation.

Two factors that could change the sunspot intensity are (i) a change in the Wilson depression and/or (ii) a change in the efficiency of non-radiative energy transport. As can be seen from sunspot models, the deficiency in gas pressure, with respect to the undisturbed photosphere, at a depth of unit optical thickness in a sunspot, is an extremely sensitive function of the Wilson depression (Maltby, *Sol. Phys.*, **55**, 335, 1977). Thus, very small changes in the Wilson depression are sufficient to account for the observed change in the relative intensities. On the other hand, any change in the efficiency of non-radiative transport, possibly caused by changes in the magnetic properties of the sunspot, could result in changes in the radiative output. Both these possible causes for the change in the relative intensity are closely linked with the theory of the formation and structure of sunspots.

A similar effect could be thought of as existing for starspots too. The stars that are suspected to be spotted, show changes in their light output which are attributed to the passage of regions of differing intensity across the line of sight. The secular changes in the mean depth of the light curve have been monitored and are attributed to possible variations in the latitudinal and longitudinal extent of the spot phenomenon (Bopp and Evans, *Mon. Not*, R. *astr. Soc.*, **164**, 343, 1973). However, no significant changes in the B-V colour were detected at that time. Hence the spot was assumed to be completely black in their model. More recent BVRI observations of BY Draconis (Davidson and Neff, *Astrophys. J.*, **214** 140, 1977) did show up changes in the R-I colour. These observations fit a starspot model, which, spart from requiring a change in longitudinal extent from 200° to 220° in about an year, needs a change in average spot temperature from 3780 K to 3670 K. It remains to be seen whether further photometric observations would show a definite trend in the variation of starspot temperature and intensity. Spectroscopy of this and similar stars at various phases of the light variation will almost certainly yield a better insight into the spot phenomenon in general.

P. Venkatakrishnan

Indian Institute of Astrophysics
Bangalore 560034

FROM DUST TO DUST AND IN BETWEEN

The intersteller grains have fascinated astronomers for the past five decades. We know that something in the form of tiny submicroscopic sized solid particles exists out there. However, their true nature is still an enigma. Michael J. Barlow [*Mon. Not. R. Astr. Soc.*, **183**, 367-395 (Paper I), 397-415 (Paper II), 417-434 (Paper III), 1978] has investigated the destruction and growth of dust grains in various astrophysical situations. We summarize some of his results.

In Paper I, the physical sputtering, by which lattice particles in a solid grain material are knocked out by bombarding atoms or ions, has been discussed. From the existing experimental data for low energy sputtering it has been concluded that $E_T = 4H_S$ where, E_T = the threshold energy below which no sputtering occurs and H_S = the mean energy required to remove one lattice molecule from a grain surface. It appears that the threshold energy E_T and the sputtering yield (Y) at low energies of the incident particles are independent of both the angle of incidence and the energy transfer factor. E_T and Y depend only on H_S. This suggests that the sputtering ejection mechanism must be a process of resonance energy transfer rather than a billard ball-type collision sequences often used in the existing theories of low energy sputtering. A table is given for the sputtering yield factor (S) for various grain materials and incident particles like hydrogen, Helium and CNO group. The atoms and ions of the same element are considered to give the same value of S.

Assuming a hot gas in equipartition the thermal sputtering rate in H II regions is important for H and He only. Both these atoms give identical contributions with the assumed abundance of $n_{He}/n_H = 0.1$. Only ice grains at the outer edge of a dense H II region surrounding early type stars would suffer significant destruction due to sputtering. The lifetime of grains in this case is $\sim 10^4$ years which is of the same order as the dynamical lifetime of a dense H II region. The sputtering in an inter-cloud medium seems to be unimportant.

Shock waves produced by cloud-cloud collisions or by expanding supernova remnants can also cause sputtering of grains. Here, unlike the situation for hot gas in equipartition (H II region), the CNO group makes a significant contribution to the total sputtering rate in a shock, whereas H atoms make only a maximum of 16% to the total sputtering rate. This difference in behaviours between light and heavy particles is explained as follows. The sputtering rate is proportional to the product of velocity (v) and energy ($\frac{1}{2} \cdot mv^2$) of the incident