THE MOTION OF CHARGED DUST PARTICLES IN INTERPLANETARY SPACE

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The problem of electromagnetic perturbations of charged dust particle orbits in interplanetary space has been re-examined in the light of our better understanding of the large scale spatial and temporal interplanetary plasma and field topology. In the equatorial plane, the magnetic sectors, caused by the warped current sheet, produce stochastic orbit perturbations. From this a diffusive description of particle motion can be derived, provided the dust particles are sufficiently small. The effects of large unipolar magnetic field regions at high heliographic latitudes will be briefly discussed.

REFERENCES

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DISCUSSION

Giese: Do you intend to convert your orbit calculations for interstellar grains into three-dimensional flux or number-density distributions? This would be extremely helpful for planning the search for interstellar dust by the IPSM Mission.
Morfill: Yes.

McDonnell: One expects interstellar particles to be incident from the Earth apex direction which is at a moderately high latitude - about 45^{o}. Should these particles therefore penetrate the solar system and then be swept out along equatorial regions? Could this be a source of beta-particles observed by probes in the ecliptic?
Morfill: This is an intriguing possibility raised by our calculations. To really test this possibility we would like to investigate theoretically

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the solar-cycle variation of the beta-fluxes and compare this with Helios and Pioneer data. The fact that beta-particles seem to come from a narrow beam centred very close to the Sun is encouraging but at this stage is not sufficient evidence to say that they are definitely all interstellar particles.

Keller: It takes the dust grains several years to reach the inner solar system from the outer heliosphere. How does the solar cycle (change in sector boundaries) affect your results?
Morfill: Solar cycle variations affect dominantly the high inclination orbits (see Morfill and Grün this volume). The diffusion region is only affected weakly in the sense that close to field reversals on the Sun the diffusive (stochastic field) effects extend to higher heliographic latitudes. The magnitude of the scattering is relatively unaffected by this.

Gustafson: Concentrations of interstellar grains as a function of the solar cycle are predicted in a paper by Gustafson and Misconi appearing in "Nature".

Mukai: How long does it take the grains to diffuse from the ecliptic plane due to the stochastic perturbations?
Morfill: It depends on position and particle properties. The diffusion time may be defined as $t_D = r^2/D_{\parallel}$, where r is the distance from the Sun, and $D_{\parallel}$ the spatial diffusion coefficient (for full expressions see Morfill and Grün 1979a, b), then for particles with radii 10^{-5}cm this time is typically of the order of one year. This fast time emphasizes how important electromagnetic effects are for submicron particles.

Gustafson: Why did you choose this model of interstellar grains?
Morfill: Firstly, our choice of an olivine-type particle for interstellar grains reflects our ignorance of interstellar solids. We have the Q pressure values for a variety of materials and will calculate them as well (including ice which has the problem of melting inside a few AU). Secondly, as far as the diffusive effects of the stochastic magnetic field are concerned, the cutoff size below which particles cannot penetrate the inner heliosphere depends only weakly on particle parameters. For example, choosing ice - charge 2 volts, density 1 g/cm^3 - yields exactly the same size cutoff of 10^{-5}cm as the original olivine particle.
Gustafson: You say that interstellar grains entering the solar system at low and medium heliocentric latitudes will not reach the inner solar system. Then their mantles of ice-type materials should be preserved.
Morfill: According to our calculations this situation applies only to interstellar dust grains with radii less than about 10^{-5}cm. Larger particles can penetrate further, but then will evaporate at some point.

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