ment schemes, university research fellowship schemes, joint appointments — whatever it is we can do, any expedience to get over this dreadful business. I would point out perhaps that in your funding survey you didn't place much emphasis on the important part that UFC funds actually play in supporting the domestic programme and the research groups. There are research groups spread over many universities in this country and some of them are going to be in real difficulty under the new funding arrangements. They should certainly be agitating within their universities, within SERC, and within UFC wherever possible to make sure that this activity can keep going. I would support strongly your remarks about Europe, and I would hope that in some way we can find a real synergy between the European efforts and the efforts which some of us have managed to achieve on the Northern Hemisphere Observatory. We must have opportunities for collaboration between south and north. Now you have given us a view of the future. I have to say that the future does run on pretty fast. I realize that you have kept yourself up to date — in fact I was told that even at teatime you were rewriting part of your talk. You have in fact been shooting at a moving target, and you have hit it right on the button. Thank you very much. [Applause.]

The President. The meeting is now adjourned until Friday 1992 March 13.

MEETING OF THE ROYAL ASTRONOMICAL SOCIETY

Friday 1992 March 13 at $16^{h}\,00^{m}$
in the Scientific Societies' Lecture Theatre, Savile Row

M. Lester, *Vice-President*
in the Chair

Secretaries: B. A. Hobbs
K. A. Whaler

The Vice-President. It gives me great pleasure to announce the names of the five associates elected by Council this morning. They are K. Fuchs, B. Hidayat, J. Melnick, J. L. Le Mouel, and C. T. Russell. [Applause.]

Our first talk is by Professor Ulmschneider, from Heidelberg, who will speak about 'Pulsating Stars'.

Professor P. Ulmschneider. The κ-mechanism which drives the pulsation of δ-Cephei stars can best be understood from its analogy to the petrol engine. In a petrol engine an inward-moving piston compresses a mixture of air and petrol which is ignited at the moment of highest compression. The excess pressure generated drives the piston back out with greater velocity, and thus puts energy into the pulsational motion. There are two important aspects of this pulsation driver, the *energy source* (petrol) and the *trigger* (spark) which releases the energy at the right phase of the cycle.

In a contracting layer of a pulsating star, because of essentially adiabatic conditions, the gas pressure and temperature both rise. It happens in δ-Cephei stars that under such conditions the opacity, κ, (hence κ-mechanism) also rises, which leads to a blocking of the flow of radiation through the star. The radiative energy which originates from the nuclear processes in the stellar core, and which in other phases of the cycle flows freely to the stellar surface, is intercepted in the contracting layer just at the phase where temperature and pressure are highest. As in the petrol engine, the excess pressure from the intercepted energy subsequently reverses the contraction and generates vigorous expansion. For the κ-mechanism the energy source is the stellar radiative flux and the trigger is the opacity.

There are other types of energy, for instance mechanical energy, which flow out of a star. One might imagine an occasional strong acoustic shock front. If such a strong shock enters an atmospheric layer it imparts a large amount of momentum to the gas, which leads to a vigorous outflow. However, when this flow, generated after the passage of the shock, has continued for some time, the material cools rapidly by adiabatic expansion, and the resulting decreased pressure is eventually unable to support the overlying weight of the atmosphere. The layer thus reverses its outflow, contracts again, and forms a second shock which again moves outward.

This, at first sight, might be an appealing pulsation mechanism, and numerical simulations indeed show that such pulsations occur in stellar atmospheres. However, these pulsations do not last very long, because this mechanism is very expensive in energy. It can be shown that, for usual stellar conditions (*e.g.*, on the Sun), most of the mechanical energy from such shocks is efficiently converted into radiation, which in turn quickly leaves the star. In order to drive shock-induced pulsations for more than one or two cycles, one needs a persistent energy source.

Now all late-type stars have convection zones, where large amounts of acoustic wave energy are produced by turbulent gas motions. A wave-train of short-period acoustic waves, emanating from the convection zone, quickly forms sawtooth-type shock waves of small amplitude, due to the steepening from the rapid density decay of the atmosphere. Occasional overtaking of one small-amplitude shock by another generates a strong shock, which sets the atmosphere in pulsational motion. This pulsating motion in turn induces shock overtaking at the right phase, where a fast-moving, small-amplitude shock of the acoustic wave in the high-temperature compression region catches up with the next, slow-moving shock in the cool region in front of it. Thus, compared to the κ-mechanism, this shock-overtaking-pulsation (sop-) mechanism has acoustic waves as an energy source, and, as a trigger, the shock-overtaking process.

It is important to realize that, for a small-amplitude acoustic shock in a wave train to catch up with another shock moving in front of it, the wavelength must be small enough. For the Sun, the sop-mechanism only works for waves with periods of less than 40 s, or about one-fifth of the atmospheric cut-off period. Such waves are observed on the Sun, and the sop-mechanism is a very promising process to explain the chromospheric bright points or so-called K_{2V} cell grains, observed in the *H* and *K* resonance lines of Ca II. In these grains large supersonic up- and down-flow motions have been detected, which so far have been difficult to explain (for more details see Rammacher and Ulmschneider, *A.&A.*, **253**, 586). It is found that the induced sop-pulsation collects essentially all the energy of the acoustic spectrum shorter than 40-s period. There have been speculations that this pulsation mechanism may also be important for other late-type stars, particularly for giants, where it may assist the large mass loss observed. This is presently under investigation.

The Vice-President. We have plenty of time for questions.

Dr. C. Jordan. Can your results be scaled to lower surface gravities and densities, so we could extend the theory to cool giants and supergiants where we know that there aren't any magnetic fields?

Professor Ulmschneider. We are looking into this. It might be interesting as a mechanism for causing mass loss, since if it happens in a red giant it could drive blobs of gas out of the atmosphere. I had a student working on this but unfortunately he was recruited by IBM. [Laughter.] So I haven't done the homework to report to you.

Dr. N. O. Weiss. Would there be any connection with magnetic fields that guide the acoustic waves?

Professor Ulmschneider. The mechanism works independently of any magnetic fields. It can also work locally; there need not be a global oscillation. Acoustic waves can be generated in regions where there are large velocity gradients, for instance near granulation boundaries.

The Vice-President. If there are no more questions, we move on to the next talk, by Professor Roederer, from Alaska. He will tell us about 'Magnetospheric Plasma Physics: Cartoons, Pet Theories, and Real Physics'.

Professor J. G. Roederer. Solar–terrestrial physics (STP) evolved from a collection of synoptic studies of individual regions to a truly interdisciplinary science, focussing on the solar–terrestrial system as an integrated whole. STP has become 'the study of space itself', that is, the study of the medium between the solar photosphere and the neutral atmosphere of Earth. Its aim is to achieve a comprehensive understanding of the generation, flow, and dissipation of energy and the transfer of mass throughout the solar–terrestrial system. Like any research endeavour of global dimensions, STP demands international coöperation and the sharing of resources, as well as new modes of research, such as multi-point measurements in space and hand-in-hand work with ground-based data, theory, and simulation.

The Solar-Terrestrial Energy Program (STEP 1990–1997) was established by the ICSU Scientific Committee on Solar–Terrestrial Physics (SCOSTEP) to advance the quantitative understanding of the coupling and feedback mechanisms that regulate the flow of energy and mass in the solar–terrestrial system. The main practical goal of STEP is to improve the predictability of the effects of the variable components of this flow on the terrestrial environment, on technological systems in space and on Earth, and on the biosphere.

Magnetospheric physics is an important component of this study because it deals with a region that is (*i*) accessible to systematic *in situ* measurements with multiple satellites and (*ii*) amenable to continuous monitoring from the ground with networks of magnetometers, optical instruments, and radars. Furthermore, this discipline offers an unparalleled opportunity to study some fundamental plasma processes that are known to occur elsewhere in the Universe.

Launched during the International Geophysical Year, magnetospheric physics has become a complex science because of the eminently non-linear character of the system, which in many aspects is chaotic and inherently unpredictable. Not unlike the study of the global climate system, we have our hands tied by the limits of global 'observability' on the one hand, and the limits of current computer power on the other. In the atmospheric sciences, some scientists are