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E.V.R.I.S. ON BOARD MARS 94: THE FIRST SPACE EXPERIMENT DEVOTED TO STELLAR SEISMOLOGY.

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ABSTRACT The EVRIS experiment is an exploratory mission devoted to stellar seismology. It will observe approximately ten bright stars, for 20 days each, during the cruise of the Russian "MARS 94" mission. The photometer will be able to detect amplitudes of modes as small as a few 10^{-6} magnitude.

SCIENTIFIC OBJECTIVES.

The generalisation of helioseismology to stars is a challenge of primary importance for basic stellar physics. The rationale for such an aim has already been developed several times (i.e. Hudson et al. 1986, Praderie et al. 1989, Baglin, 1990). Looking at nearby stars will provide information on different stellar structures and evolutionary phases, for instance, on the structure of convective cores which governs the age of stars more massive than the Sun, on the laws of rotation in faster rotators and on the transfer of angular momentum processes. But the major difficulties when going from the Sun to stars is the lack of photons and the lack of spatial resolution.

WHY A SPACE MISSION?

The need to go to space has already been extensively documented (see i.e. Mangeney and Praderie 1984, Hudson et al. 1986, Baglin 1990, Weiss 1992). Two methods are available to observe faint stellar oscillations (Harvey, 1989). The spectroscopic one can be used from the ground, but it needs extremely large telescopes for long periods, and in any case, it is limited to slowly rotating objects. Indeed, the aforementioned scientific objectives cannot be achieved with this technique. The photometric approach suffers from atmospheric absorption and fluctuations, and even with recent CCD developments (see i.e. Frandsen, this conference), the threshold of 10^{-6} cannot yet be reached from the ground. From space, if the trajectory is sufficiently clean, the stability of the environment permits to reach the accuracy of the photon noise.
Since the first proposals in 1981, our philosophy has been to design an experiment as simple as possible, which could be launched as soon as possible, as an

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exploratory mission. The tremendous success of the IPHIR experiment on the PHOBOS mission has been a strong encouragement and an excellent guide.

INSTRUMENT SPECIFICATIONS.

A compromise has to be made between the necessity of collecting as many photons as possible and the weight and cost of the mission. The condition to detect a coherent signal in a pure flux of photons is:

$$N_p > A^{-2} \quad (1)$$

where A is the relative amplitude, N_p the number of photons counted per second by the detector and $q = \min(T, t)$ with T the total duration of the record, and t the life-time of the signal. Using the solar values as references (A being a few 10^{-6} and t a few days), condition (1) implies $N_p > 10^6$.

The International Scientific Committee for the MARS 94 mission has accepted a small asteroseismology experiment of a total weight of less than 7 kg., installed on a pointing platform, operated during cruise. These constraints have lead to the following choices:

* a diameter of the pupil of 7 cm, a large bandpass of the order of 2000 Å, centered in the visible region, and a total efficiency of the chain of detection of 0.1.; values which limit the investigation to objects brighter than $m_v \approx 3.5$;

* a large diaphragm (radius 8') to include the diffraction pattern at an accuracy of 10^{-5};

* a photometer with a small PM (Hamamatsu) working in counting mode.

TARGETS.

The constraints are numerous. They apply essentially to:

* the visual magnitude, as already discussed; if we accept to lower the detection threshold then some fainter objects could be observed;

* the luminosity class (main sequence or subgiants), to keep simple objects and time scales of pulsations around a few hours and less;

* binaries, only with a much fainter component, to avoid confusion;

* the visibility from the spacecraft; as the instrument must point towards the antisolar direction, it is installed below the solar panels, and only one half a hemisphere will be visible;

* the surrounding sky, which has to be as clean and as well known as possible, to reduce the external noise generated by the parasite sources entering and leaving the diaphragm due to pointing fluctuations.

Taking into account all these limitations, an interesting set of targets is available (Fig.1), with a wide variety of masses, ages, chemical compositions and states of rotation.

OBSERVING STRATEGY.

We will observe first a known variable to check the instrument, then stars of different types. If after 5 days, no signal is obtained on a target, the observation

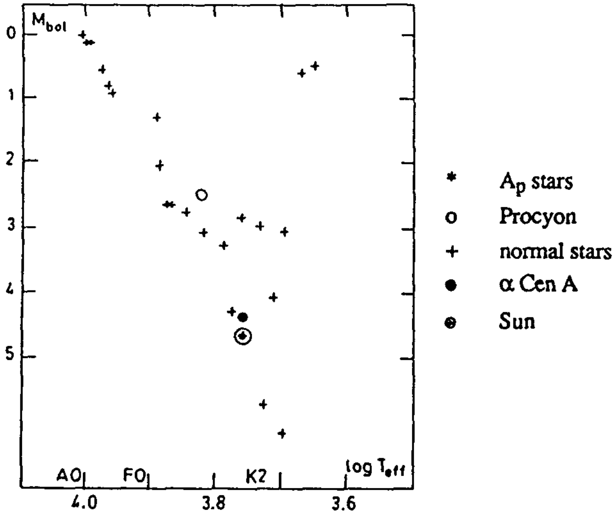

FIGURE I HR diagram of possible targets.

will be stopped and another object will be pointed; on the contrary, if the spectrum is very rich, the decision can be made to continue longer on the same target. Results will be obtained almost in real time, every 5 days during the telemetry sequences. Reductions will be made independently by the French, the Austrian and the Russian teams, and then the results will be made available to the scientific community.

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REFERENCES

Baglin, A. : 1990, *Solar Phys.*, **133**, 155.
Baglin, A.: 1991, *Adv. Space Res.*, **11**, 133.
Frandsen, S. : 1992, this conference
Harvey, C. : 1988, in *Advances in Helio-and Asteroseismology* (J. Christensen-Dalsgaard and S. Frandsen eds.), p. 497.
Hudson, H.S., Brown, T.M., Christensen-Dalsgaard, J., Cox, A.N., Demarque, P., Harvey, J.W., Mc Graw, J.T., Noyes, R.W.: 1986, A concept for an Asteroseimology Explorer. Proposal submitted to NASA.
Praderie, F., Mangeney, A., Lemaire, P., Puget, P., Bisnovatyi-Kogan, G. : 1988, in *Advances in Helio-and Asteroseismology* (J. Christensen-Dalsgaard and S. Frandsen eds.), p. 549.
Mangeney, A., Praderie, F. : 1984, *Proceedings of the workshop on Space Prospects in Stellar Activity and Variability*, Paris Observatory Press.
Weiss W. : 1992, this conference.