23

EVRIS

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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. Some objects of masses lower than the solar one will allow to test the thermodynamics.

EVRIS est la première expérience dévouée à la sismologie des étoiles. Elle sera lancée par la mission Russe MARS 94. Elle observera une dizaine d'objets, chacun pendant une vingtaine de jours, avec un seuil de détection de quelques 10^{-6} magnitude. Plusieurs étoiles de masse plus faible que celle du Soleil devraient permettre des tests significatifs de leur thermodynamique.

23.1 An exploratory instrument for asteroseismology.

23.1.1 Scientific objectives and strategy.

After the success of detection, measurements and interpretation of the eigemodes of the Sun, it is tempting to try to achieve similar progress on other stars and to allow for a comparative and differential study of the seismical stellar behavior.

The major difficulties when going from the Sun to stars is the lack of photons and the lack of spatial resolution. The rationale for such an aim

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has already been developed several times (i.e. Hudson et al. 1986, Praderie et al. 1988).

The need to go to space has also been extensively documented (see i.e. Mangeney and Praderie 1984, Hudson et al. 1986, Baglin 1990, Weiss 1992).As an important and costy mission is difficult to defend and to launch, it was decided to propose first a small mission with a quite restricted program, but exploring the field.

After 10 years with various attemps and versions, we have finally succeeded in being selected on the Russian MARS 94 mission. The EVRIS experiment will work during the 300 days cruise to MARS, then stop when the spacecraft enters the MARS neighbourhood and starts orbiting the planet.

23.1.2 The instrument.

The instrument is a classical photometer, working in photon counting mode, in a large bandpass (3000 Å) centered on the visible region, to collect as many photons as possible. Due to the limited weight and space (and also to the small budget!) available, we had to restrict ourselves to a very small telescope; the diameter of the entrance pupil is 70mm.

Associated to a stellar sensor, it is placed on a pointing platform (PAIS) designed and manufactured by IKI (Russia), and situated in the shadow of the solar panels of the spacecraft. The pointing accuracy is 30 arcsec.

23.2 Detection threshold for a coherent signal.

The condition to detect a coherent signal in the Fourier space, if the noise level is limited by the Poisson photon noise is:

$$N_p \, inf(T,t) > A^{-2} \tag{1}$$

A, amplitude of the coherent signal; N_p, number of photons collected in 1s.; T, duration of the observing run (in s.); t, time of coherence of the signal.

EVRIS is able to detect amplitudes of a few 10^{-6} in 5 days for stars brighter than $mv \approx 3.5$ in the frequency range 0.1 to 10 mHz. At lower frequencies, the level of detection increases due to the unavoidable rise of instrumental and environment sources of noise (Fig 1).

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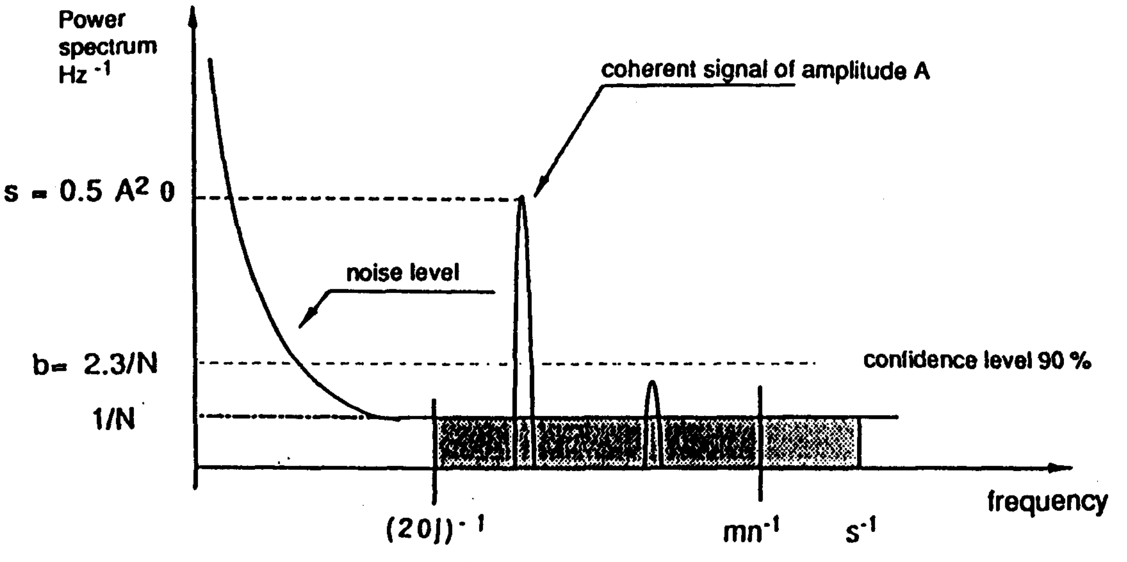

Fig. 23.1 Detection threshold of a coherent signal as a function of frequency.The power spectrum of a coherent signal is compared to the spectrum of a representative noise (white noise plus instrumental noise at low frequency).

23.3 Choice of the observing program.

The observing program is not yet completely fixed. It is submitted to many constraints due to instrumental conditions, like visibility from the space craft, stellar sensor operations, level of instrumental noise and to the scientific specifications.

23.3.1 Possible Targets.

Approximately 180 stars fullfill the preliminary conditions.

Excluding giants and OB stars for which the characterisitic timescales are too long, 46 objects remain up to now. Their position in a luminosity/surface temperature diagram (the so-called HR diagram) is shown on Fig.2.

A final choice will be done to improve the scientific return.

Some stars lie in the lower part of the main sequence, and their structure is essentially controlled by thermodynamics. Their envelope is convective, then independent of the radiative transfer but governed by the equation of state. They have been observed by Hipparcos (See Baglin (1993), this

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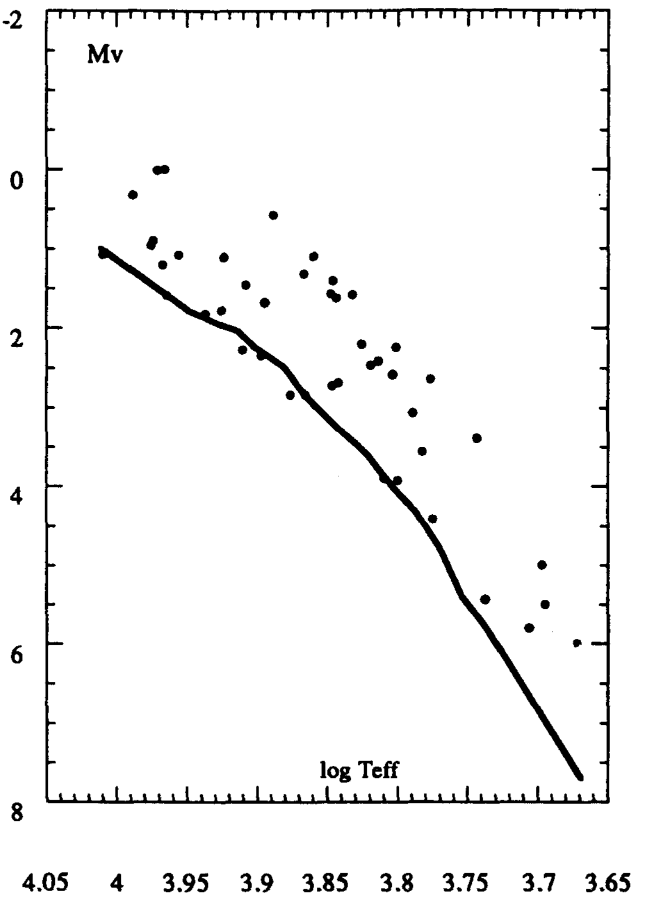

Fig. 23.2 HR diagram of possible targets. Absolute visual magnitudes and effective temperature are computed through the Genava calibration (Hauck, 1973, 1985).

conference), and their modelisation will then be strongly constrained. If pulsations are detected, they will permit to test precisely the stratification in the convective zone.

23.3.2 Duration of the runs.

It will be fixed during the mission depending on the first results, but never shorter than 5 days. The term $inf(T,t)$ in eq.1 will be optimised.

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23.4 Post EVRIS projects.

- COROT, a small mission proposed to CNES, to follow a few objects, detected by EVRIS as multimode pulsators. The runs on each object will be longer to study the statistic of the amplitude and frequency of the modes.

If accepted, the launch is scheduled around 98.

- STARS, a M3 ESA proposal to be flown around 2005 (see Lemaire(1993), this conference), is now selected for an assessment study.

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