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THE IRIS NETWORK FOR WHOLE DISC HELIOSEISMOLOGY: RECENT RESULTS

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ABSTRACT

IRIS(International Research on the Interior of the sun) is the name of a worldwide network of 6 stations for whole disc Doppler shift measurements. The network has been operating since 1987 and by now a few series of a hundred days long unbroken (by day/night periodicity) data were received. Analysis of these data allowed to receivesome new results which are discussed in the paper.

Key Words : helioseismology-solar ratation

I. INTRODUCTION

It was shown by twenty-year intensive research that helioseismology is an efficient method for the solar internal structure study. This method is based on an accurate measurements of observed friquencies of solar oscillations. For this reason any helioseismological project has to obtain long unbroken temporal sequencies of data, which can provide a high-frequency resolution detection of indivisual modes.

The IRIS project(fossat,1991) provides such data by means of worldwide network of 6 station,which were put in operation one by one since 1987.these stations are: stanford(USA), Kumbel(Uzbekistan), Oukaimeden(Moroco), Izana(Tenerite, Spain), La Silla(chile), Coolgura(Australis).

The IRIS instrument measures the Doppler line-of-sight velocities integgrated over the whole solar disk. It is then sensitive only to the very low degree modes (l=0,1,2,3) of oscillations which bring an information about the deepest parts of the solar core (Grec etal.1991)

II. IRIS DATA QUALITY

The eight-year IRIS network operation shows that it can provide with a 3-4 months long temporal sequencies of data per year.A frequency resolution of such data strings is about 0.1 μ Hz, which is good enough for precise determination of mode's frequencies as well as for their rotational splitting measurements. However, an efficiency of our measurements is limited by a background noise level caused by the instrument itself, terrestrial atmospheric effect (Ehgamberdiev Khamitov,1991) and the solar convective velocities. Fig.1 show the average of 300 daily IRIS power spectra. Flat noise in the high frequency part beyound 10 mHz is mostly due to a photon statistics. Its level is about 10 m^2s^{-2}/mHz and increases with aging (darkening) of the optical parts ofo the instrument and decreases when we replace them by new ones. This noise becomes important for the estimation of the acoustic energy of waves which penetrate into the chromosphere. The value of that energy is proportional to the integral of a power beyond the cut-off frequency -5.5 mHz after subtracting the noise level (Fossat et al.,1992) the atmospheric and instrumental noise are concentratated in a low frequency part of the power spectrum. As one can see its level lays much below the solar convective velocity background noise, theoretically estimated by Harvey (1985).

On the one hand Fig. 1 shows that it must be resetimated, but on the other hand it demonstrates the efficiency of our methods for atmosphereic effect corrections since for a long time this level was inaccessible for ground based observations. The low frequency noise level achieved in the space GOLF experiment is 2-2.5 times lower (Palle, private communications). However, the GOLF data were obtained in the spring 1996 when the solar activity was in the minimum phase while the best IRIS data were obtained during the period of the maximum. So, before the final conclusion about groundbased data limitations a variation of solar background noise with activity cycle should be studied. A very important part of the spectra lays around 1.6 mHz. There a low frequency tail of the acoustic power spectrum is located. The peaks there are very narrow and are usually for rotational splitting measurements. Fig2 demonstrates just one peak 1686.6 μHz which has an amplitude about 1cm/s. The mean noise level in the Fig2 is about 0.06 m^2s^{-2}/mHz. At a frequency resolution of 0.08 μHz it correspond to 2mm/s. So, the observational limit in the IRIS data for the week peak detection is about a few mm/s.

III. ROTATIONAL SPLITTING

The solar surface rotation was intensively studied using the tracking of tracers, such as sunspots, faculae, supergramulation cells, etc. The results of different technique can be summarized in some empiric formula which gives an equatorial period of rotation of 25 days (corresponds to 462 nHz) and a polar period of 34 days(440 nHz). Nearly ten years ago the resolved helioseismology experiments had been showed that the latitudinal differential rotation is persisted down to the base of convection zone (Libbercht, 1988). Moreover it

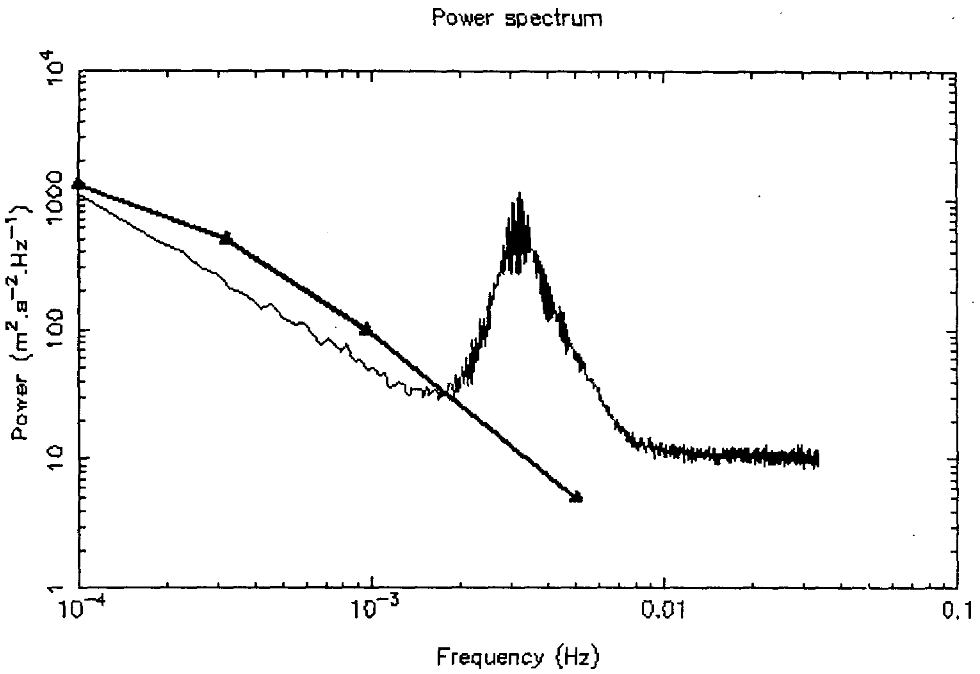

Fig. 1.— A mean of 300 dayly IRIS power spectrum.Solid line is the solar convective background noise estimated by harvey(1985)

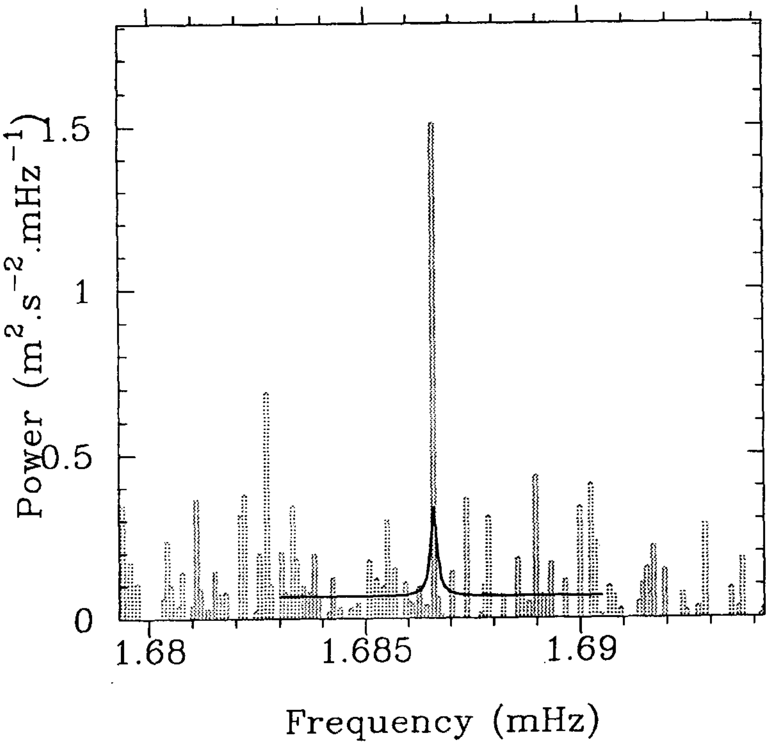

Fig. 2.— An example (a single realization) of v=1686.6 μHz (l=0,n=11)mode in the power spectrum of 1990. Amplitude of the peak is about 1 cm/s and noise level correspond to 2mm/s. A fitting is done by lorentz function.