OSCILLATIONS AND WAVES
IN THE SUN AND STARS

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Abstract: A short review is given about some characteristics of acoustic, gravity, Alfvén and MHD-simple waves. Their possibilities for probing the stellar interior, heating the atmosphere and changing spectral line profiles are discussed.

INTRODUCTION

The idea that non-thermal flux from subphotospheric layers must carry energy to the stellar atmosphere, appeared as early as it was obvious that solar corona has \(10^8\) times higher temperature than the photosphere (Biermann, 1946; Schwarzschild, 1948; Schatzman, 1949). The discovery of the photospheric 5-minute oscillations was made by Leighton et al. (1962). But it was not before 1975 (Ando and Osaki, 1975; Deubner, 1975) that oscillations and waves become one of the most exciting area of astrophysics. Very few astrophysical problems of great importance have been solved with such agreement between theory and observations. It can serve as an example of what scientific research should be like. By understanding physics of the 5-minute oscillations solar astrophysics open a window for looking into the stellar interior. P-mode oscillations have also been detected from the other stars (Fossat et al, 1984; Noyes et al, 1984; Kurtz, 1990).

Since 1975 a torrent of scientific papers about oscillations has appeared in the leading astrophysical periodicals. Moreover, several international conferences (from 1984 to 1991) were devoted only to oscillations and waves in the Sun and stars (see Ref. 1–8). It is therefore a great challenge to give a short review of such important, complex and vast topic.

Without going into details, I shall concentrate on the origin and the main characteristics of oscillations and waves. Their essential contributions are: probing of stellar interior, heating of stellar atmosphere and changing of spectral line profiles.

ORIGIN, CHARACTERISTICS AND POSSIBILITIES

There are different forces in the stellar matter (pressure, gravity, magnetic) which act immediately after a small perturbation to return fluid to initial conditions. Oscillations or waves are the response of the medium to any perturbation. Turbulence in the convection zone (CZ) is one of possible mechanisms for their excitation. Two reflection boundaries (a resonant cavity) can produce a large number of resonant modes. There are about \(10^7\) resonant modes of solar interior. Such a rich spectrum of detected oscillations arises from modes whose periods vary from a few minutes to several hours, and their horizontal wavelengths vary from less than thousand kilometers to global scales (Gough and Toomre, 1991).