RAY TRAPPING IN STELLAR ENVELOPES, PULSATIONAL INSTABILITIES AND HEATING OF EXTERNAL LAYERS

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Abstract. The relation between local criteria for hydrodynamic instabilities and stellar stability is reconsidered. This leads to a discussion of the classical problem of stellar pulsation with a special emphasis on the pressure modes of high order spherical harmonics. It is shown that within the frame of the geometrical approximation, acoustic rays exist which are trapped inside any specified slab of a stellar envelope. The pressure modes associated with such rays are conjectured to give rise to small scale instabilities whenever a region exists in an envelope where any *local* criterium indicates pulsational instability. The model is expected to support and somewhat extend the recent developments concerning the role of pressure non-radial modes on the dynamics of the solar atmosphere and the heating of external layers.

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DISCUSSION

Wilson: Would you identify then the oscillations like the 5-min oscillations with the T-modes that are trapped below the surface.

Souffrin: Yes, that has been suggested by several people. I can give some numbers to make it more specific. We may ask what wavelengths and frequencies are expected in the Sun within the framework of observations. It turns out that periods may be expected in the range 250–750 s. This gives wavelengths of 2500 to 25000 km. The numbers that are best suited to the ray approximation give a period of 350 s and λ about 8000 km. This is just right and I am happy with that.

Stix: Did you compute growth rates for these oscillating modes? We have computed some but I think we still need more growth rates.

Souffrin: The growth rates computed by Ulrich and Wolff are maybe good to order of magnitude, but this is really a technically difficult point and I do not have too much confidence in the calculations. In the Ulrich calculations the boundary conditions are not well known. In Wolff's calculations he uses the variational principle in the specific case where it is not really applicable. I understand from Bob Stein that he is doing this kind of computation, and in Nice, George Conczi is also doing the calculations. This will come out very soon.

Uchida: Would you expect regions of high and low temperature in the photosphere associated with the T-mode?

Souffrin: Well, yes, it is a pressure mode, but I have not looked into this question.

Delache: There are two wavelengths in your results, the wavelength of the ray and the wavelength of the acoustical wave. Which wavelength have you given? And can you give the other one?

Souffrin: I am speaking of the acoustical wave. I have not calculated the wavelength of the ray.

R. Grant Athay (ed.), Chromospheric Fine Structure, 293.