ON THE EXISTENCE OF HYDROMAGNETIC INTERFACE WAVES AT A STRUCTURED ATMOSPHERE

K.SOMASUNDARAM , S.MANTHIRAMOORTHI
DEPARTMENT OF PHYSCIS , GANDHIGRAM RURAL INSTITUTE
GANDHIGRAM 624 302, TAMIL NADU, INDIA

AND

A.SATHYA NARAYANAN , DEPARTMENT OF APPLIED MATHEMATICS,
INDIAN ISNTITUTE OF SCIENCE, BANGALORE 560 012, INDIA.

ABSTRACT: The conditions under which the hydromagnetic interface waves can exist at a magnetic interface is deduced. Using these conditons, it is shown that a slow interface wave with a phase velocity about 5Km/s and a fast interface wave with a phase velocity 6.5 to 8km/s at the photospheric level can exist.

1.INTRODUCTION: It is a well established fact that the solar atmosphere is highly structured. Such structured atmosphere supports a spectrum of Alfven waves(Uberoi,1972). When the stratification is approximated to a single discontinuity, it has been shown that the interface supports hydromagentic interfacial waves (Wentzel, 1979; Roberts,1981a; Uberoi and Somasundaram, 1980). Studies of such waves help to understand the observation of the wave motion on solar surface and the associated wave phenomena. Several studies of the interfacial waves at plane (Wentzel,1979), slab(Roberts, 1981b) and cylindrical(Uberoi and Somasundaram, 1980) geometries have been reported. Such studies, even for the simple plane interface, were done by numerical evaluation of the dispersion relation of the interfacial wave. Therefore, given an atmospheric condition, it is difficult to infer whether such surface can support an interface wave or not. In this note , the interface wave propagation along a plane interface separated by two compressible plasma embedded in a magnetic field is considered. The conditions underwhich the slow and fast magnetoacoustic interface wave can exist are deduced. These conditions are applied to test the existence of the interfacial wave at the photospheric level.

2.DISPERSION RELATION. Solving the linearized MHD equations for the perturbations of the form $f(x,z,t) \equiv \exp i(kz + \omega t)$, for the two plasma media in $x>0$ and $x < 0$, embedded in a manetic field $B_{01} = B_{01}\hat{z}$ and $B_{02} = B_{02}\hat{z}$ with equilibrium

E. R. Priest and V. Krishan (eds.), Basic Plasma Processes on the Sun, 262–263.

mass density ρ_{01} and ρ_{02} in the two media respectively and applying the boundary conditons one obtains the dispersion relation as (Roberts 1981a):

$$\rho_{01} (k^2V_{A1}^2 - \omega^2) m_2 + \rho_{02} (k^2V_{A2}^2 - \omega^2) m_1 = 0 \qquad (1)$$

where $V_{A1,2}$ are the bulk ALfven wave velocities in the two media 1 and 2,

$$m_{1,2}^2 = \frac{(k^2V_{A1,2}^2 - \omega^2)(C_{1,2}^2k^2 - \omega^2)}{(C_{1,2}^2 + V_{A1,2}^2)(k^2C_{T1,2}^2 - \omega^2)} \qquad (2)$$

$$C_{T1,2}^2 = C_{1,2}^2 V_{A1,2}^2 / (C_{1,2}^2 + V_{A1,2}^2) \qquad (3)$$

3.DISCUSSION: For an interfacial wave , real roots of equation (1) exists only when

$$\max (V_{A1}, V_{A2}) < \omega/k < \min (V_{A1}, V_{A2}) \qquad (4)$$

and m_1 and m_2 are to be positive for a interface wave. It can be shown from equations(1)-(4), that a slow magnetoacoustic interface wave can exist only when

$$V_{A1} < \omega/k < \min (C_1 , C_{T2}) \quad \text{for } V_{A1} < V_{A2} \qquad (6)$$

$$\text{or } V_{A2} < \omega/k < \min (C_2 , C_{T2}) \quad \text{for } V_{A1} > V_{A2}$$

and a fast moagnetoacoustic interface wave can exist only when

$$\max(V_{A1} , C_2) \ \omega/k < \min (C_1 , V_{A2}) \text{ for } V_{A1}<V_{A2}$$

$$\text{or } \max(V_{A2}, C_1) \ \omega/k < \min (C_2 , V_{A1}) \text{ for } V_{A1}>V_{A2} \qquad (7)$$

Earlier results (Roberts, 1981a; Somasundaram and Uberoi, 1982; for the case l=0; Miles and Roberts,1989) can be easily obatined using the conditions in equation(6) and (7). Consider the case C_1=8 km/s , V_{A1}=5 km/s at the photospheric level and C_2=8 km/s , V_{A2}=8 km/s above the photosperic level as given by Nye and Thomas(1974). At this interface,one can expect a slow manetoacoustic interface wave with a phase velocity about 5km/s and a fast interface wave with a phase velocity 6.5 to 8km/s.

REFERENCES

Miles, A.J. and Roberts,B.:1989, Solar Phys. 119,257.

Nye, A.H. and Thomas, J.H.:1974, Solar Phys. 38, 399.

Roberts, B.:1981a, Solar Phys. 69 , 27.

Roberts, B.:1981b, Solar Phys. 69 , 39.

Somasundaram, K. and Uberoi, C.:1982, Solar Phys. 81 , 19.

Uberoi, C. and Somasundaram, K.:1980, Plasma Phys. 22 , 747.

Uberoi, C.:1972, Phys. Fluids 15 , 1673.

Wentzel, D.G.:1979, Astrophys. J. 227 , 319.