MHD WAVE PROPAGATION IN THE SOLAR NETWORK

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ABSTRACT

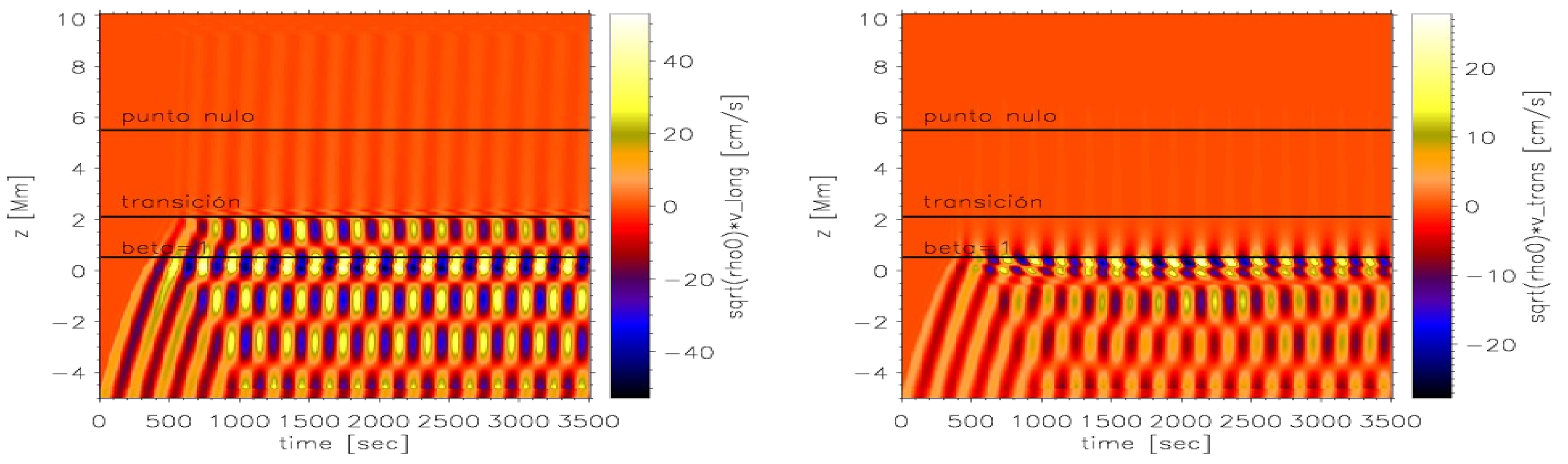
In order to understand the behavior of the MHD waves in magnetized regions of the solar atmosphere, we present a two-dimensional numerical simulations of wave propagation in the solar network, from sub-photospheric layers to the corona. We study what happens when they reach the transition region or the mode convertion zone, where the wave transformation occurs. It is also interenting to discuss what happens when a null point appears, like in this case.

INTRODUCTION

We used a two-dimensional numerical code to simulate the wave propagation in the solar atmosphere from the sub-photosphere up to the corona. We choose a force-free magnetic field to prevent instabilities in the equilibrium state. The configuration of the magnetic field is composed of two magnetic flux tubes on both sides of the numerical grid and, arc-shaped field lines between them. We also have a null point located in the corona, which changes the behavior of the waves. We have a magnetic field strengths of 100 Gauss in the surface and 10 Gauss in the corona. For the temperature distribution, we used the Parchevsky & Kosovichev model (Parchevsky & Kosovichev, 2007), for the deeper layers (convection zone) ,and the VALC model (Vernazza et al., 1980), for the layers between the surface and the transition region. For the corona we used a constant temperature of one million Kelvin. The density and pressure were calculated analytically.

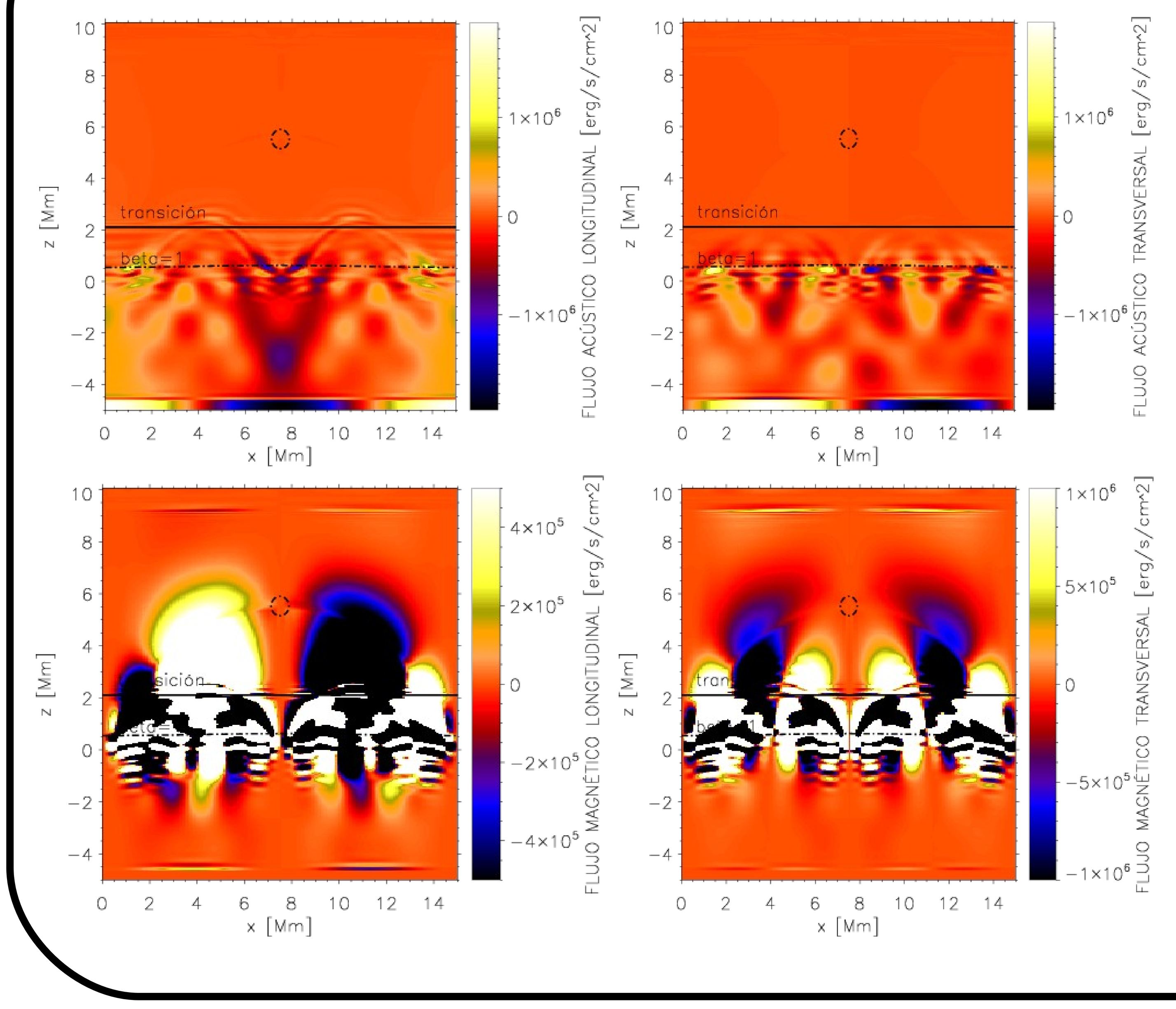
On the right hand we can see the MHD waves propagation along the solar atmosphere. We plot the, two-dimensional, longitudinal and transverse velocities. We study the behavior of the waves as they go upward, and see what happens when they reach the transition region, the corona, mode convertion zone, null point, etc.

Longitudinal Velocity   Transverse Velocity



It is shown a vertical spatial cut of the longitudinal and tranverse velocities. We see the time evolution of these variables along the height. The waves start propagating up in the sub-photosphere, and they go through the solar surface to the mode convertion zone ($\beta = 1$). Due to the wave transformation there is a change in the velocities . After undergoing the transformation, the waves continue propagating upward until they reach the transition region. Here, a fraction of the waves gets reflected to the chromosfere and photosfere. The other fraction, keeps propagating into the corona. As a result of the reflections in the transition region, the waves coming from deeper layers and the reflected ones superimpose and become stationary .

ENERGY FLUXES



They are presented, the acoustic and magnetic energy fluxes of the MHD waves. We show the transverse and longitudinal components for each flux. As we can see, in the lower atmosphere the acoustic fluxes are more important than the magnetic ones. In higher layers we see both, magnetic and acoustic components. And, if we look to the corona, the magnetic flux is the dominant. The initial total energy flux is of the order of 5×10^8 erg/s/cm^2. After crossing all the obstacles and suffering wave transformation the photospheric total flux is about 5×10^4erg/s/cm^2 and, in the corona there are approximately 2×10^4erg/s/cm^2.

LONGITUDINAL VELOCITY   TRANSVERSE VELOCITY