FORMATION OF CORONAL SHOCK WAVES

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INTRODUCTION

• Numerical simulations of magnetosonic wave formation driven by an expanding cylindrical piston are performed to get better physical insight into the initiation and evolution of large-scale coronal waves caused by coronal eruptions
• Several very basic initial configurations are employed to analyze intrinsic characteristics of the MHD wave formation that do not depend on specific properties of the environment
• It turns out that these simple initial configurations result in piston/wave morphologies and kinematics that reproduce common characteristics of coronal waves
• In the initial stage the wave and the expanding source-region cannot be clearly resolved, i.e. a certain time is needed before the wave detaches from the piston
• Thereafter, it continues to travel as a so-called "simple wave”
• During the acceleration stage of the source-region inflation, the wave is driven by the piston expansion, so its amplitude and phase-speed increase, whereas the wavefront profile steepens
THE MODEL

• We consider perpendicular magnetosonic waves
• We focus on a planar and cylindrical geometry
• the magnetic field in the z-direction, whereas the x and y magnetic-field components, as well as the z-component of the velocity, are always kept zero ($B_x=0$, $B_y=0$, $v_z=0$)
• All quantities are invariant along the z-coordinate, i.e. we perform 2.5D simulations, where the input and the basic output quantities are the density $\rho$ the momentum $m_x=\rho v_x$, $m_y=\rho v_y$ and the magnetic field $B_z$
THE MODEL

• All quantities are normalized, so that distances are expressed in units of the numerical-box length (\( L=1 \))

• velocities are normalized to the Alfvén speed \( v_A \), and time is expressed in terms of the Alfvén travel time over the numerical-box length (\( t_A=L/v_A \))

• We apply the approximation \( \beta=0 \), where \( \beta \) is the plasma-to-magnetic pressure ratio.

• The origin of the coordinate system is set at the numerical-box center
CONCLUSION

• Simulations show that in most cases impulsive shock wave is formed very close to the border areas of source so it is initially difficult to separate the two entities

• For large amplitude numerical results differ from the analytical theory, most likely due to the numerical resolution

• From the observation point of view, the cylindrical geometry is much more interesting, because it provides insight into the process of creating a shock wave driven by the expansion of the magnetic arcades, and includes an amplitude reduction due to energy conservation
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