Europska Unija
Ulaganje u budućnost
Projekt je sufinancirala Europska Unija iz Europskog socijalnog fonda

FORMATION OF CORONAL SHOCK WAVES

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INTRODUCTION

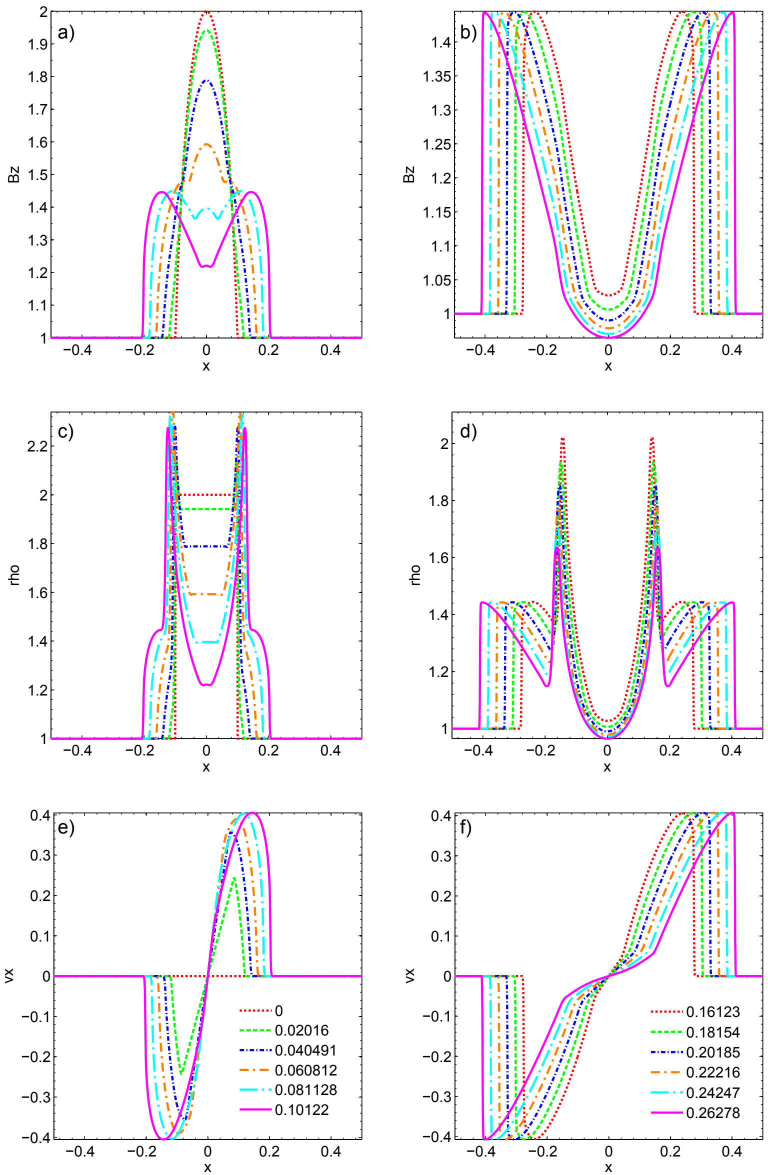
- Numerical simulations of magnetosonic wave formation driven by an expanding cylindrical piston are performed to get better physical insight into the initiation and evolution of large-scale coronal waves caused by coronal eruptions
- Several very basic initial configurations are employed to analyze 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

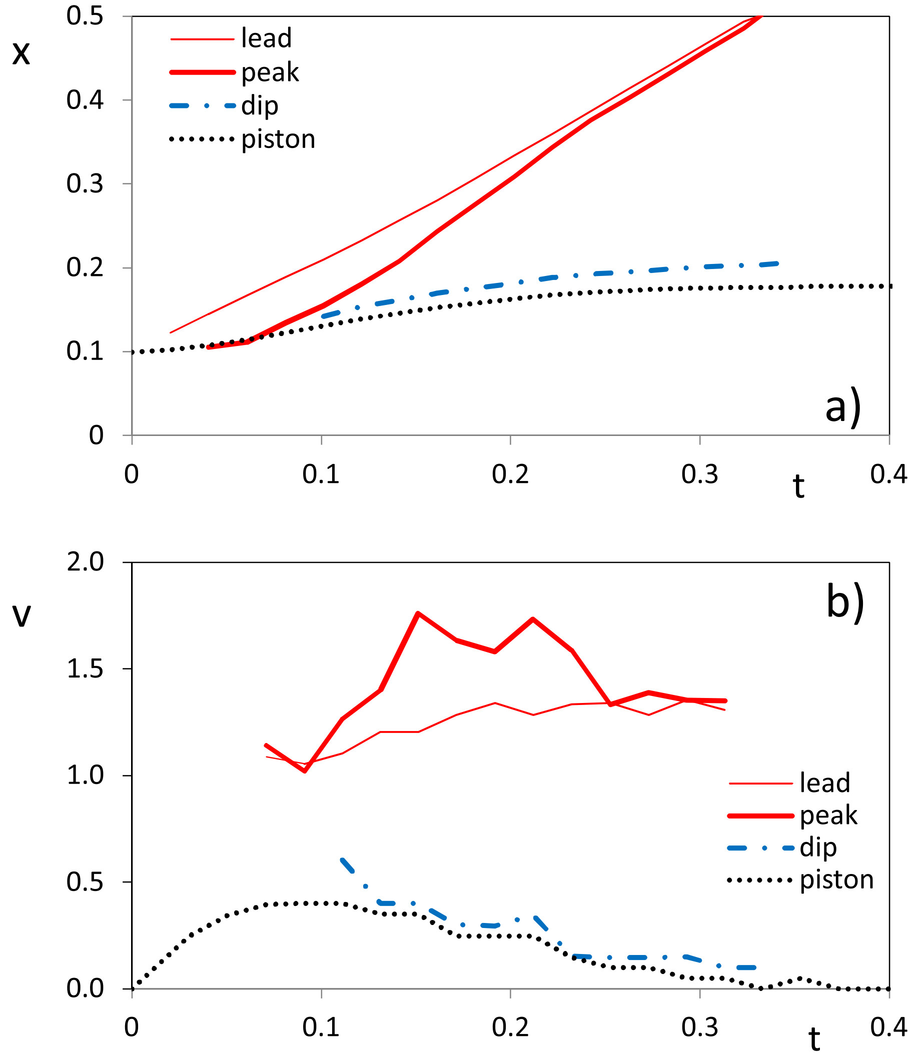
THE MODEL

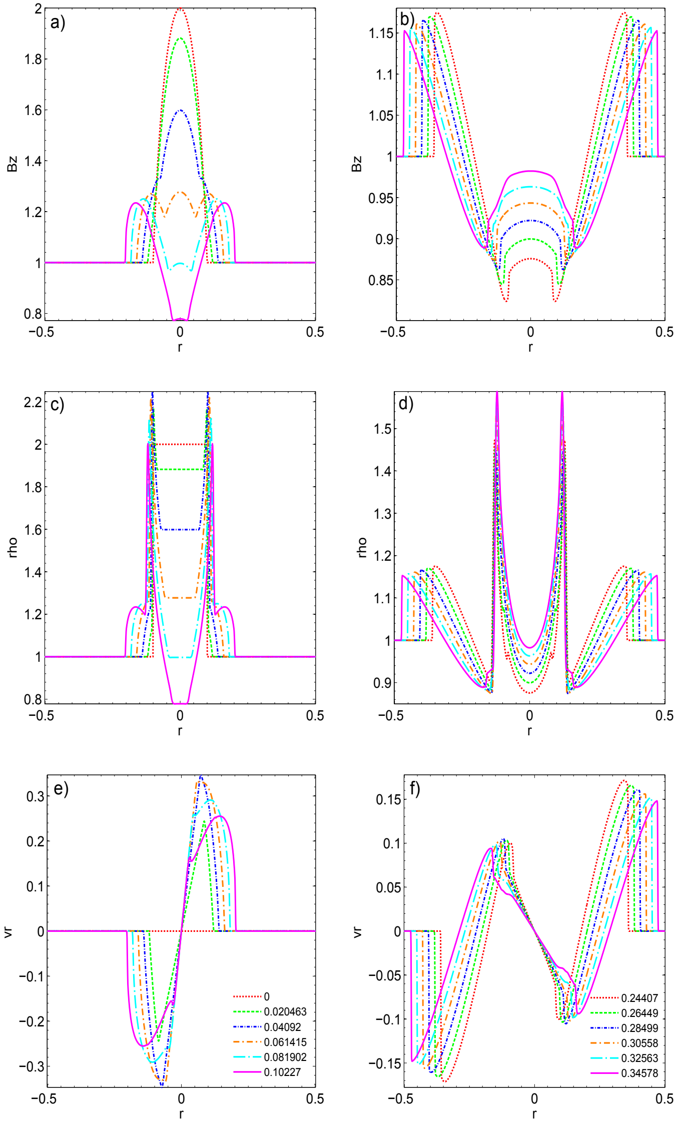
- We consider perpendicular magnetosonic waves
- We focus on a planar and cylindrical geometry
- the magnetic field in the z-direction, whereas the x and y magnetic-field components, as well as the z-component of the velocity, are always kept zero (B_x=0, B_y=0, v_z=0)
- All quantities are invariant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

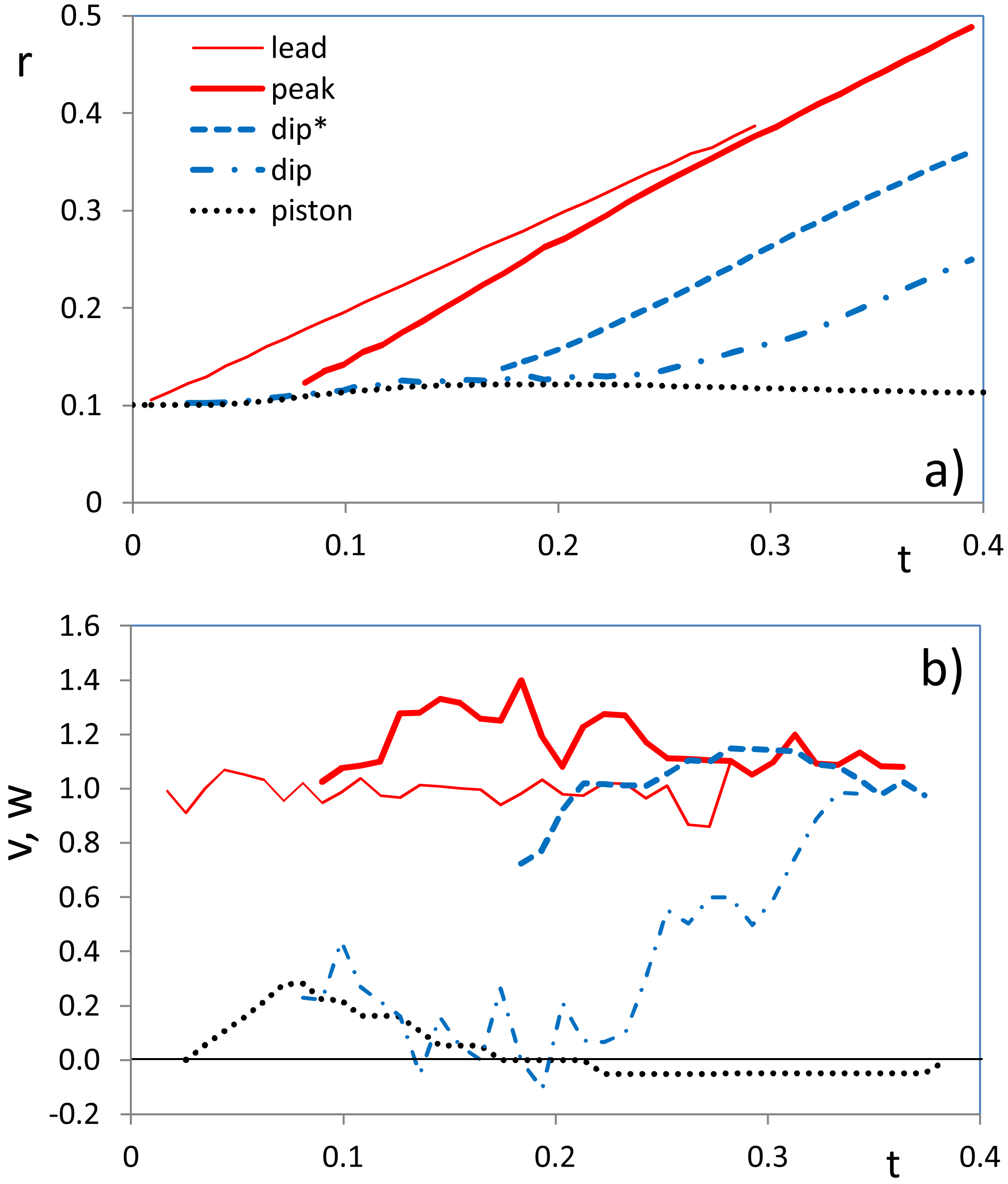
THE MODEL

- 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 β is the plasma-to-magnetic pressure ratio.
- The origin of the coordinate system is set at the numerical-box center


a)
b)
c)
d)
e)
f)
Bz
rho
vx
x
0
0.02016
0.040491
0.060812
0.081128
0.10122
0.16123
0.18154
0.20185
0.22216
0.24247
0.26278


x
t
v
a)
b)
lead
peak
dip
piston


a)
b)
c)
d)
e)
f)
Bz
rho
vr
r
0
0.020463
0.04092
0.061415
0.081902
0.10227
0.24407
0.26449
0.28499
0.30558
0.32563
0.34578


lead
peak
dip*
dip
piston
r
t
a)
v, w
b)

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

ACKNOWLEDGMENTS

- We acknowledge the support of European Social Fund under the „PoKRet“ project.