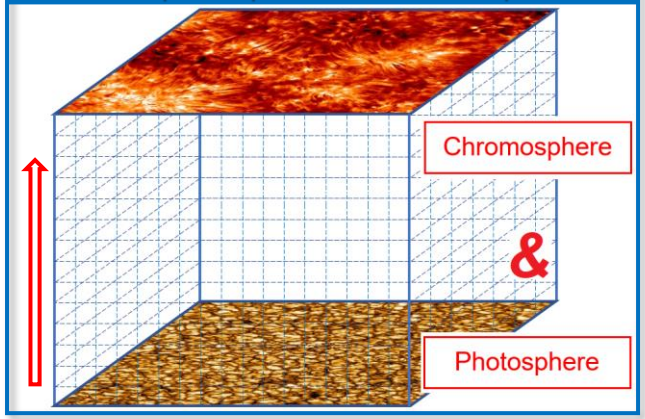
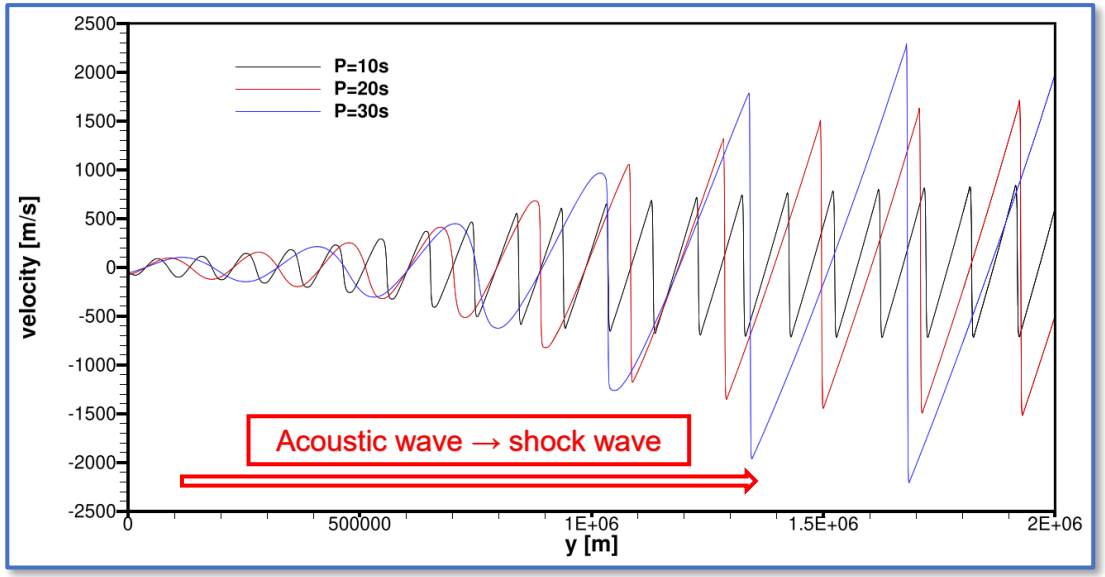
Acoustic/shock wave heating in the gravitationally stratified partially ionized plasmas: the two-fluid effects

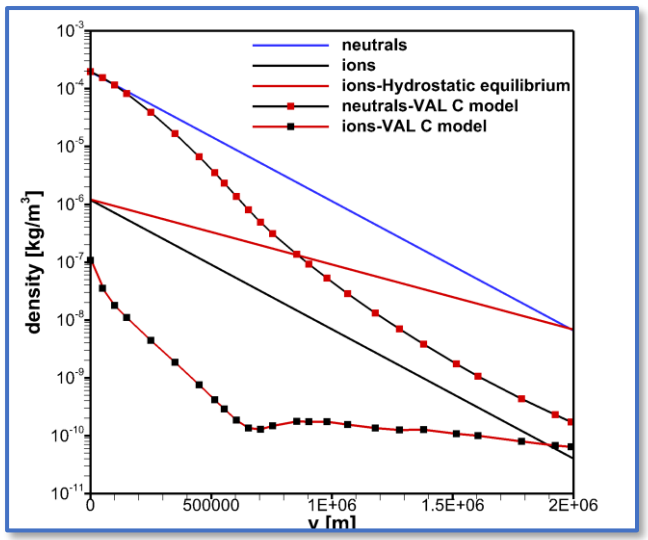
Fan Zhang (*fan.zhang@kuleuven.be*)[1], Stefaan Poedts[1,2], Andrea Lani[1], Błażej Kuźma[1] and Kris Murawski[2]

1 Centre for mathematical Plasma-Astrophysics, Department of Mathematics, KU Leuven, Belgium; 2 Institute of Physics, University of Maria Curie-Skłodowska, Poland

Idealized 1D two-fluid simulations for the photosphere and chromosphere







The Radiative Energy Losses in the Chromosphere and the Present Numerical Kinetic Energy Losses [W m^{-2}]

	Total Chromospheric Losses	Middle Chromospheric Losses (850-1500km)
Radiative losses	4× 10^3 (Withbroe & Noyes 1977)	3630 (Sobotka et al. 2016)
$\Delta F(P=10s)$	5.6 × 10^3	5.3 × 10^3
$\Delta F(P=20s)$	5.5 × 10^3	4.4 × 10^3
$\Delta F(P=30s)$	5.1 × 10^3	3.4 × 10^3

Summary

1. Initial hydrostatic equilibrium and chemical equilibrium have been and probably need to be both reached
2. A different initial equilibrium leads to a different initial density profile, while density is essential for estimating shock heating
3. In the present numerical modelling, the shock heating is sufficient to compensate the chromospheric radiative losses
4. High(low)-frequency waves tend to deposit more energy at lower(higher) altitudes
5. Collisional heating is relatively weak (not shown)
6. The density is still significantly higher than the quiet-Sun density (VAL C), and thus the shock heating is far from accurate

For more details

Zhang, F. et al. 2021, ApJ, 911, 119.
DOI: https://doi.org/10.3847/1538-4357/abe7e8

Main references

Vernazza, J. E. et al. 1981, ApJS, 45, 635.
Kalkofen, W. 2007, ApJ, 671, 2154.
Leake, J. E. et al. 2012, ApJ, 760, 109.