

# Propagation of shocks through cepheid envelopes

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A Cepheid is a supergiant variable star positioned in the instability band of the HR diagram. Spectroscopic and interferometric observations show that long-period cepheids exhibit asymmetries in the P Cygni-type profiles around the H alpha line ([4]). Indeed, one can observe an absorption and an emission component, redshifted or blueshifted depending on the pulsation phase. These asymmetries might be explained by strong shocks propagating in the envelope because of the photosphere pulsation ([1], [2]).

The aim of our work is to use the radiation hydrodynamics code HADES ([3]) to carry out simulations of shocks in cepheid envelopes according to the scenarios proposed by astronomers. An observable around the H alpha line is then reconstructed from hydrodynamic quantities resulting from numerical simulations in order to compare our results with observations.

## References :

[1] Yu.A. Fadeyev et al., "The structure of radiative shock waves. V. Hydrogen emission lines", *Astron. & Astrophys.*, 420, 03 (2004)

[2] D. Gillet, "Atmospheric dynamics in long-period Cepheids. H alpha profile variations", *Astron. & Astrophys.*, 68, A72 (2014)

[3] C. Michaut et al., "Computational Radiation Hydrodynamics", *Astrophys. Space Sci.*, 336, 175 (2011)

[4] N. Nardetto et al., "High-resolution spectroscopy for Cepheids distance determination. IV. Time series of H\_alpha line profiles", *Astron. & Astrophys.*, 489, 1263 (2008)