Experimentation with hydrogen injection flash

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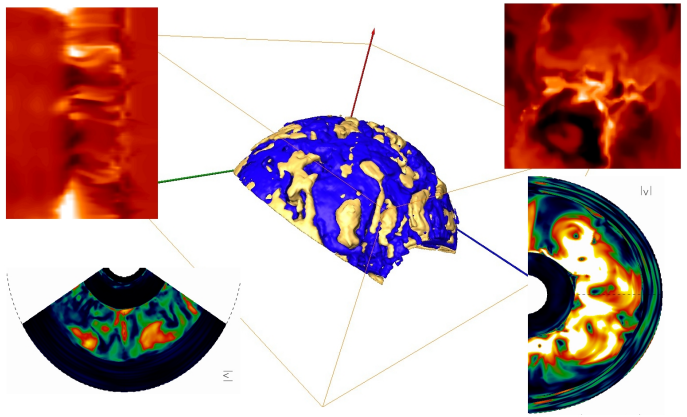


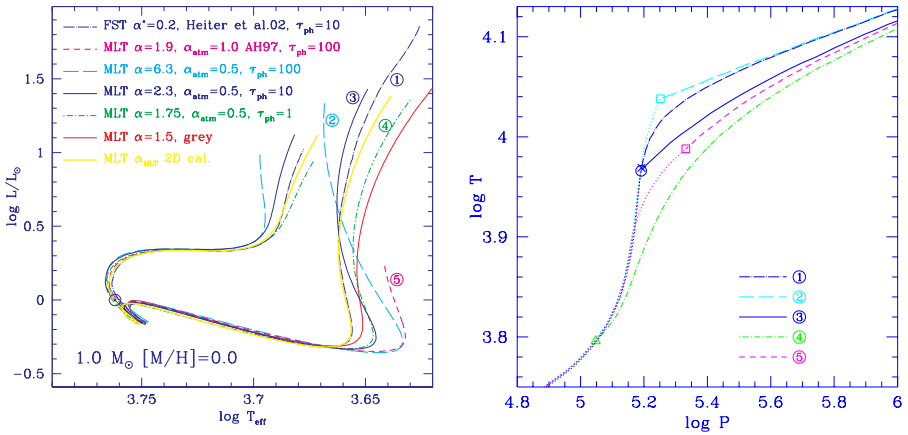
11th FNRS Contact Group meeting' 25th May 2010

Outline

- Introduction
  - Why hydrodynamics?
- Simulations
  - Turbulent Entrainment
  - Entropy Barriers
  - Dual Core Flash
- Conclusions

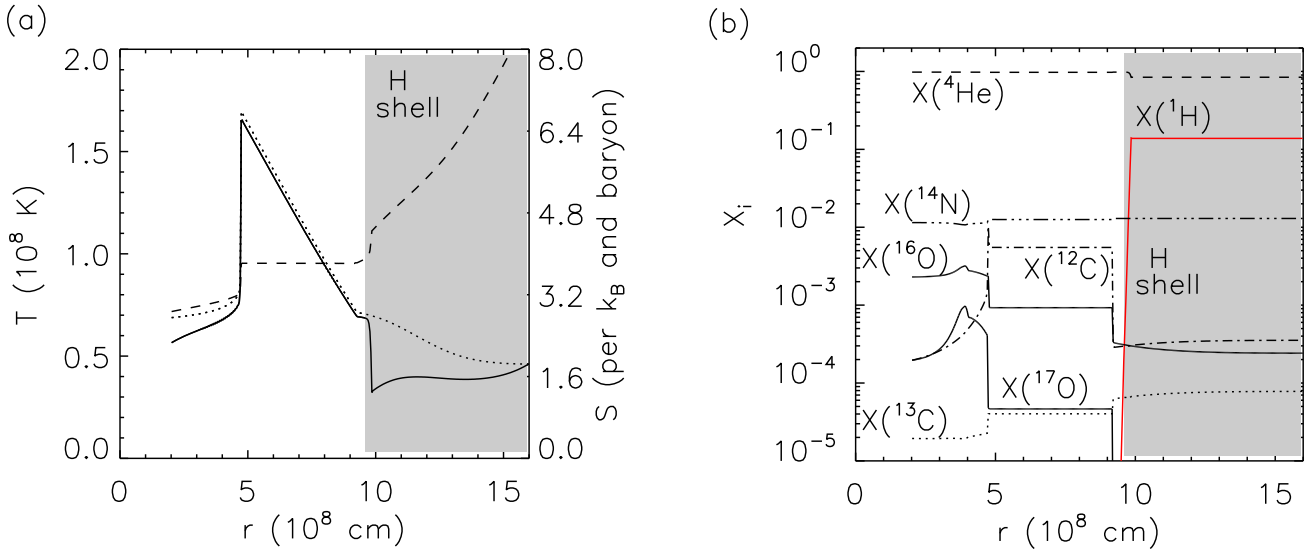
Why hydrodynamics?

- canonical stellar evolutionary calculations are hydrostatic and approximate dynamic processes by local and linear theories utilizing free parameters → **computationally not demanding** → produce observables
- hydrodynamic simulations are the best way to constrain the 1D approach as they are based on solution of Navier-Stokes equations and are essentially parameter free → **computationally demanding** → do not produce observables



- Montalbán, J.,D'Antona F.,Kupka F.,Heiter U., 2004, A&A, 416, 1081

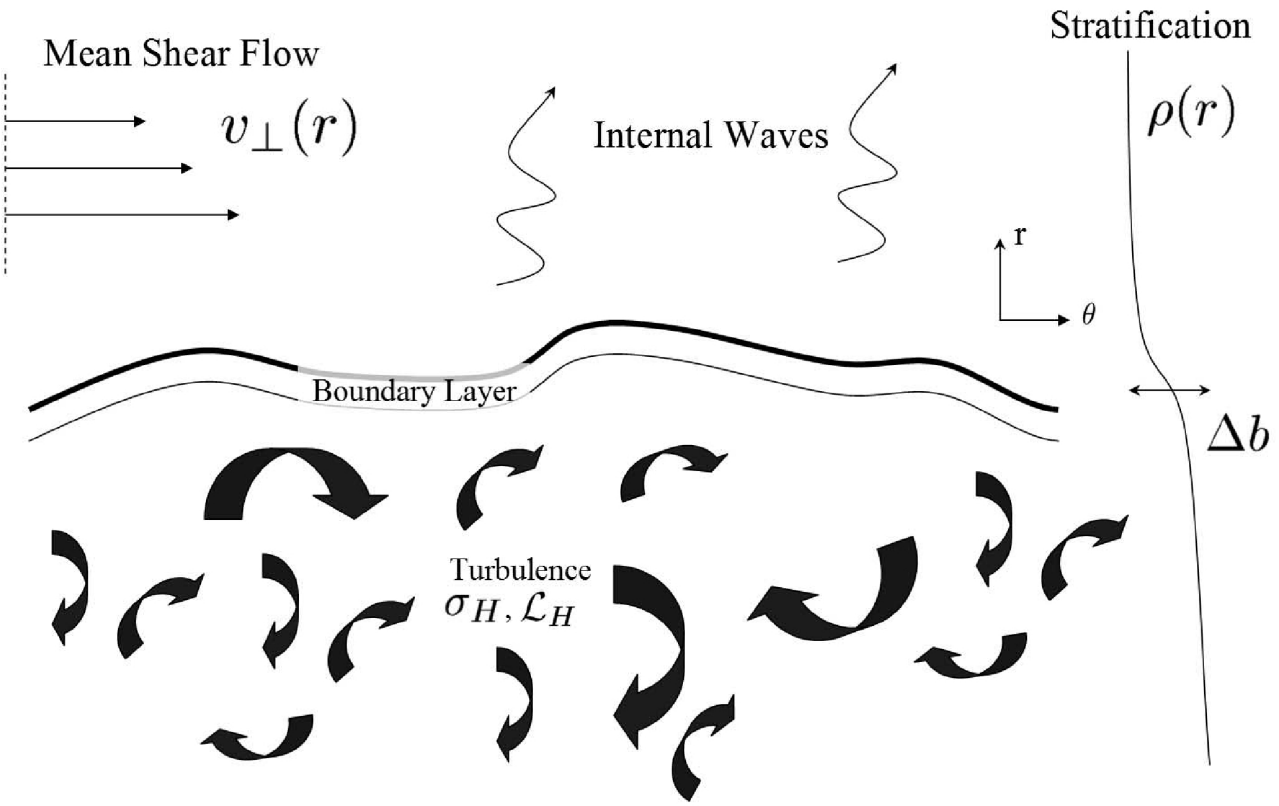
Models



(a) Core Helium Flash 1.25 $M_\odot$ with shifted hydrogen shell

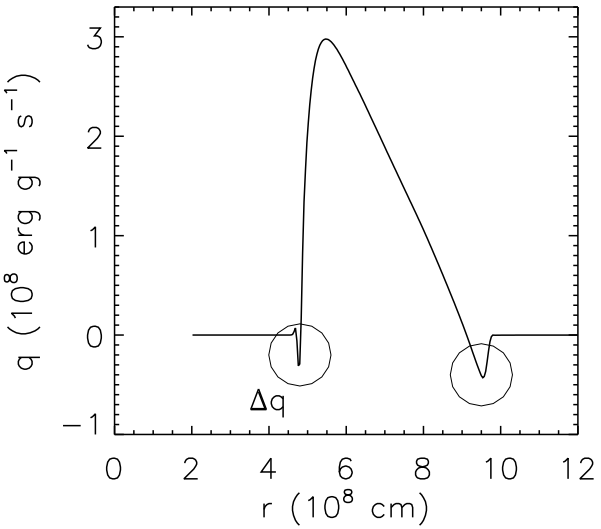
- $\rightarrow$ **watch the 3D movie**

Turbulent Entrainment



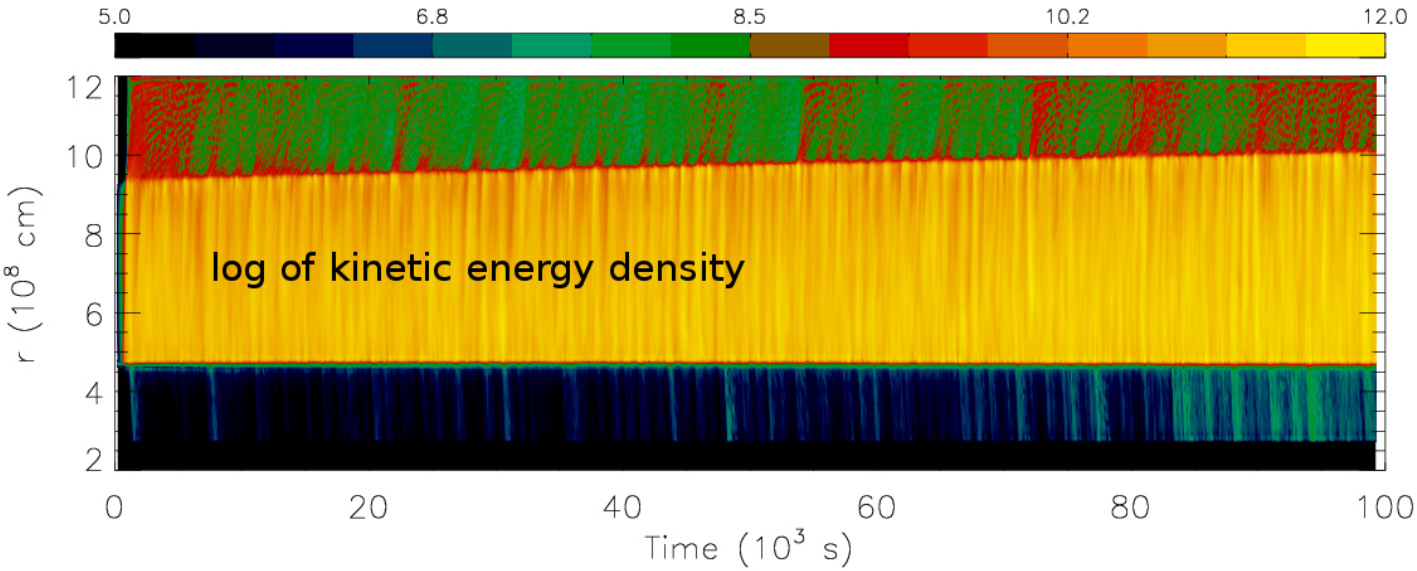
Fernando H., 1991, Ann. Rev. Fluid. Mech., 23, 455, Meakin et al., 2007, ApJ, 667, 448

Turbulent Entrainment



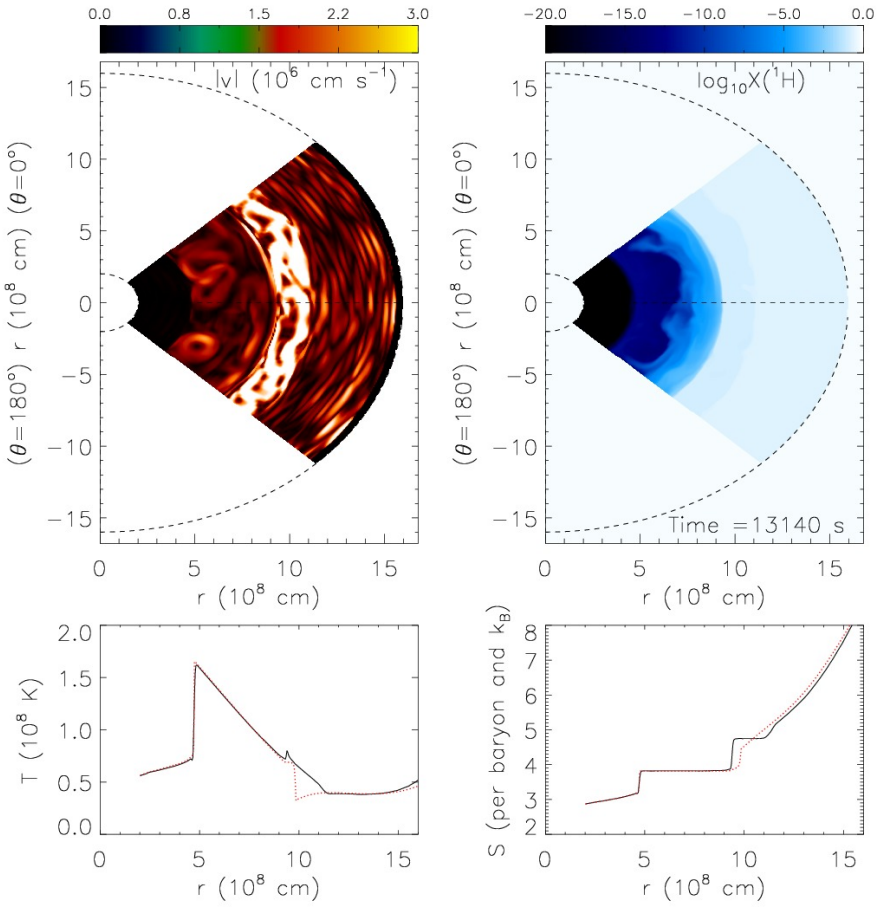
- accounts essentialy for both, penetration and overshooting
- is an exchange between the potential energy of the stratification (buoyancy jump db = N^2dr) and kinetic energy of the turbulence (buoyancy flux q)

Turbulent Entrainment and the Core Helium Flash



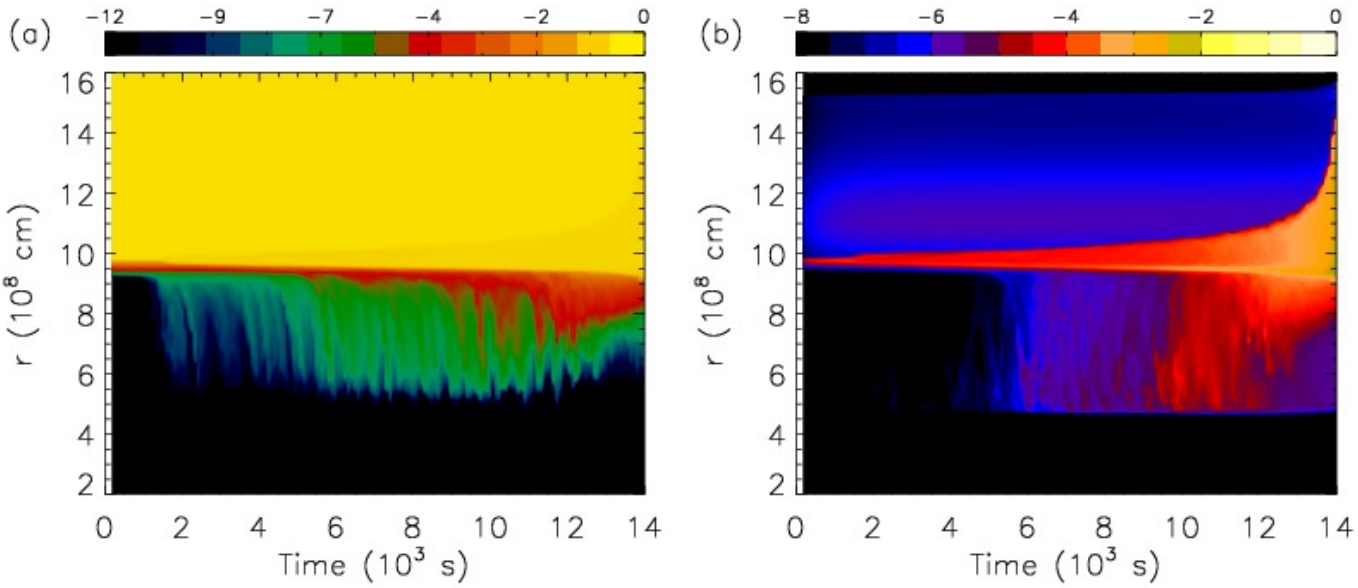
Mocák M., Campbell S. et al., Core Helium Flash Revisited III. From PopI to Pop III stars (arXiv:1003.3646)

Is the entropy barrier at H-He discontinuity an ultimate obstacle?



- **NO, it is not** → watch the movie

Mixing of elements during the hydrogen injection flash



(a) Core Helium Flash 1.25 $M_\odot$ with shifted hydrogen shell

- mixing of elements during hydrogen injection flash from H shell to the He core not completely prohibited

Conclusions

- hydrogen injection flash is possible for low-mass stars of all metalicities
- entropy barries not an ultimated obstacle for growing convection zones
- mixing of elements during hydrogen injection flash from H shell to the He core possible