H_2 in shocks models and UV excitation

1. Paris-Durham shock code

2. Influence of H_2 on shocks

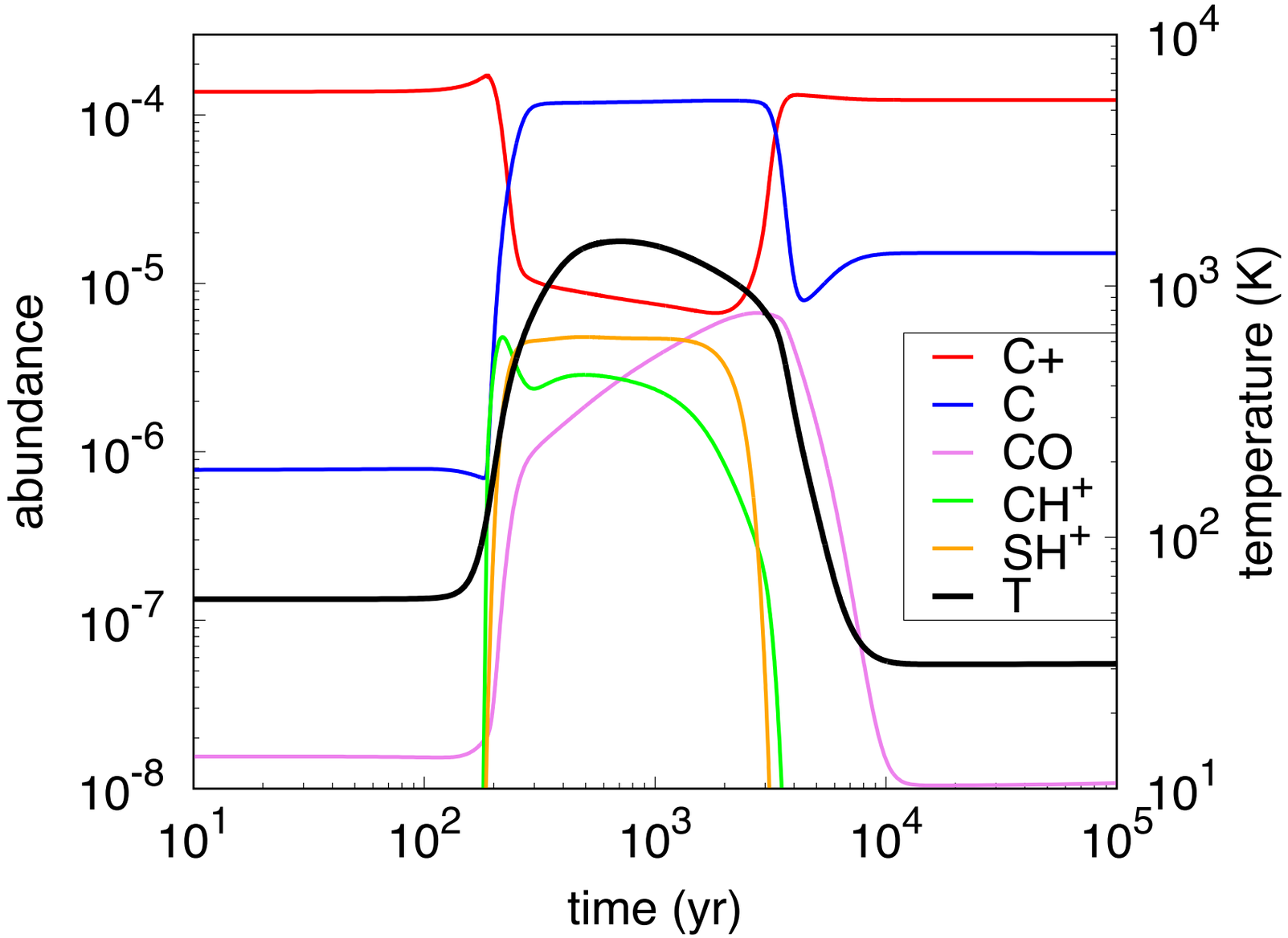
3. Influence of shocks on H_2

Paris-Durham shock model

input conditions

- wave velocity
- magnetic field
- density
- irradiation
- abundances

output - thermo-chemistry



V_S = 20 km s^{-1} B = 20 µG

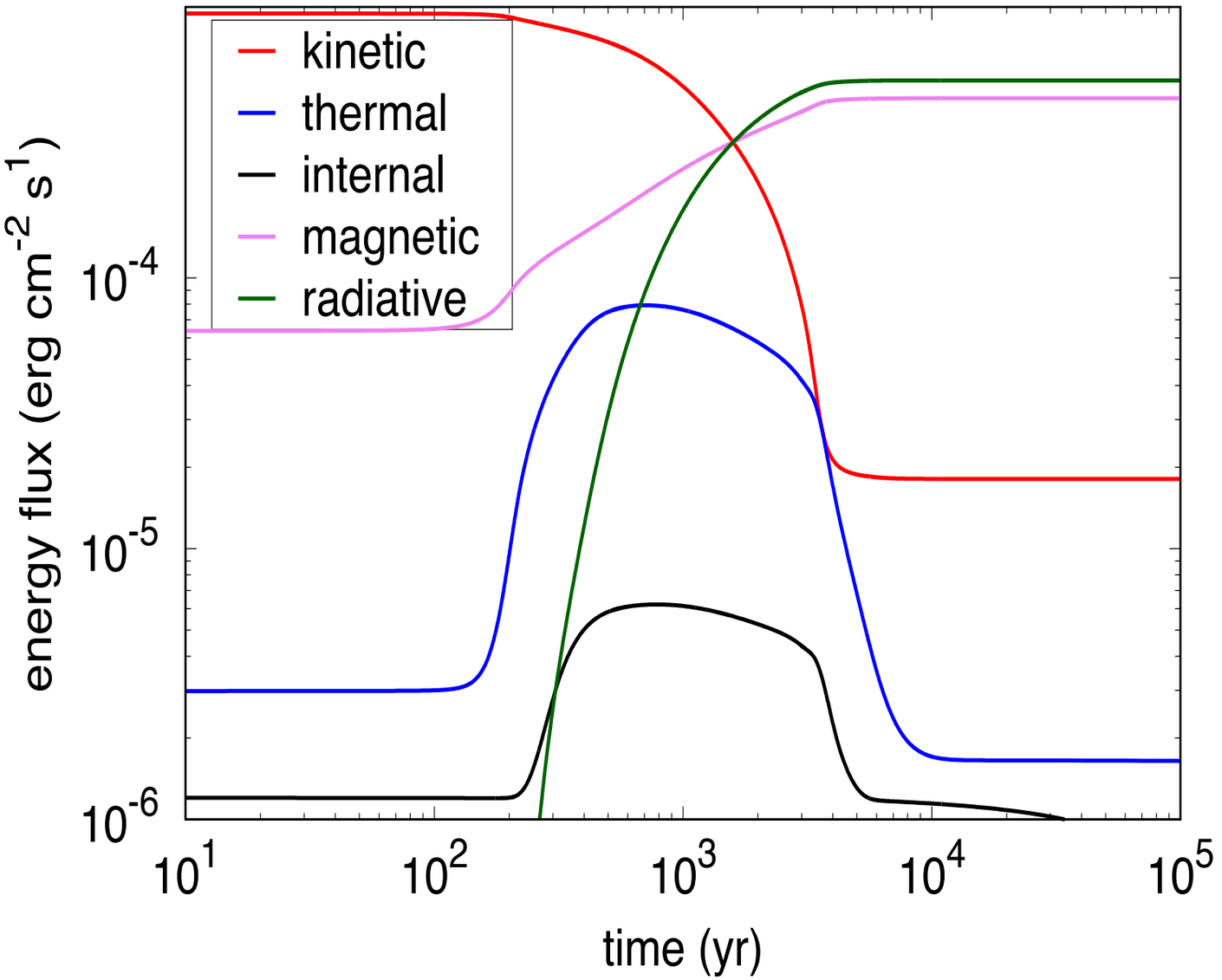
n_H = 10^4 cm^{-3} G_0 = 1, A_V = 0.1

Paris-Durham shock model

input conditions

- wave velocity
- magnetic field
- density
- irradiation
- abundances

output - energy conversion



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Paris-Durham shock model

different versions

- LVG transfer (Flower et al. 2010)
- dust dynamics (Anderl et al. 2013)
- illuminated shocks (Lesaffre et al. 2013)

✓ down/up stream rad : G_0, A_V

✓ H_2 and CO self shielding

✓ photoelectric effect

state-of-the-art

- 1, 2, 3 fluids
- J-type and C-type shocks
- $n_H < 10^6$ cm^{-3}
- $V_S < 40$ km s^{-1}
- adsorption / sputtering / desorption from mantles
- $G_0 < 10^4$

Paris-Durham shock model

treatments of H_2

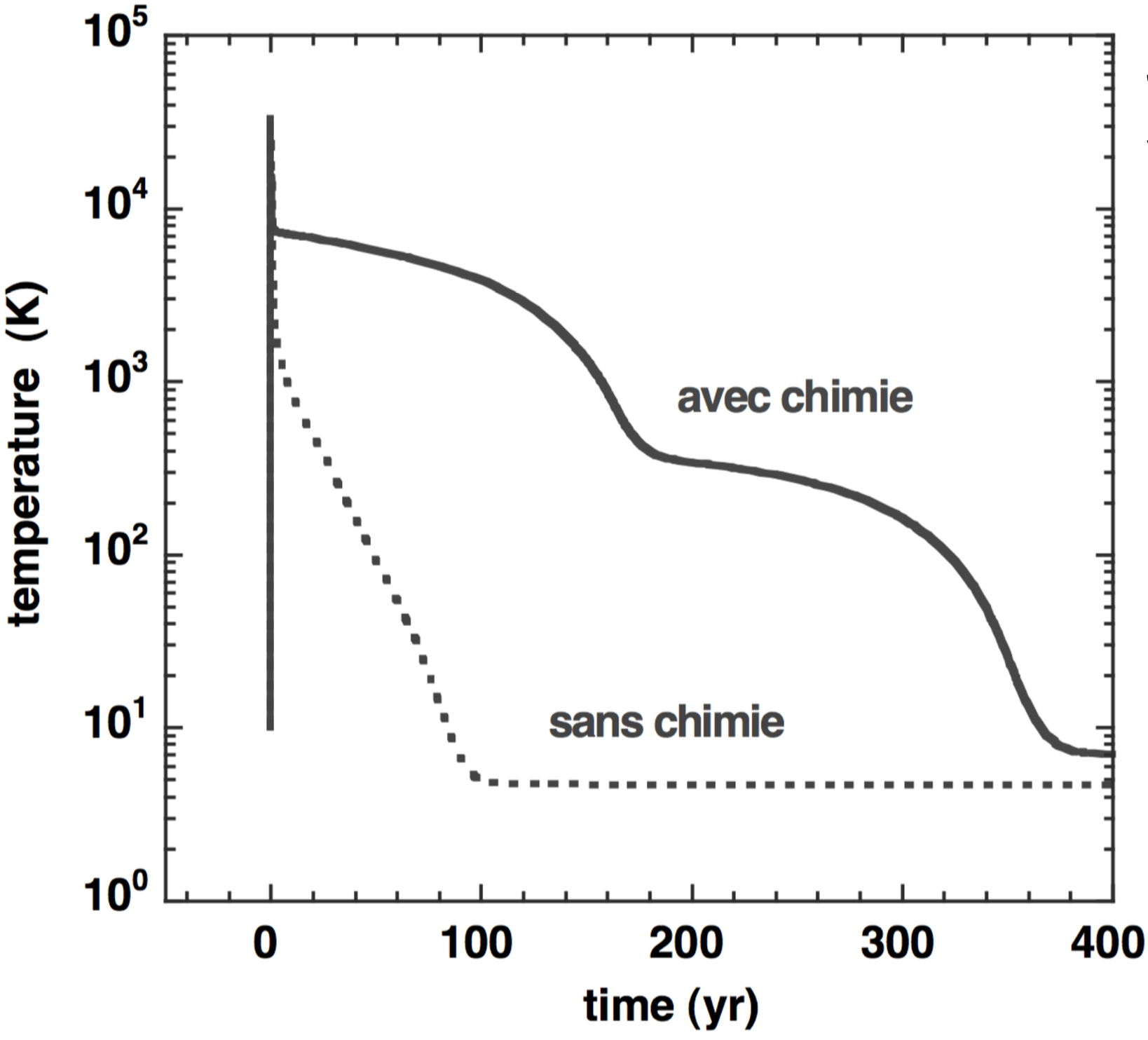
- formation on grains
  - ✓ simplistic prescription
  - ✓ $k \propto n_{\rm H}\, n_{\rm G}\, S_{\rm H}\, \nu_{\rm col}$
- excitation
  - ✓ formation
  - ✓ collisions (H, H_2, He, H^+)
  - ✓ spontaneous decay

recent improvements

- H_2 electronic lines
- coupling with UV
- cascade mechanism from PDR code (Le Petit et al. 2006)
- FGK transfer (Federman et al. 1979)

Influence of H_2 on shocks

Influence of H2 on shocks



J-type

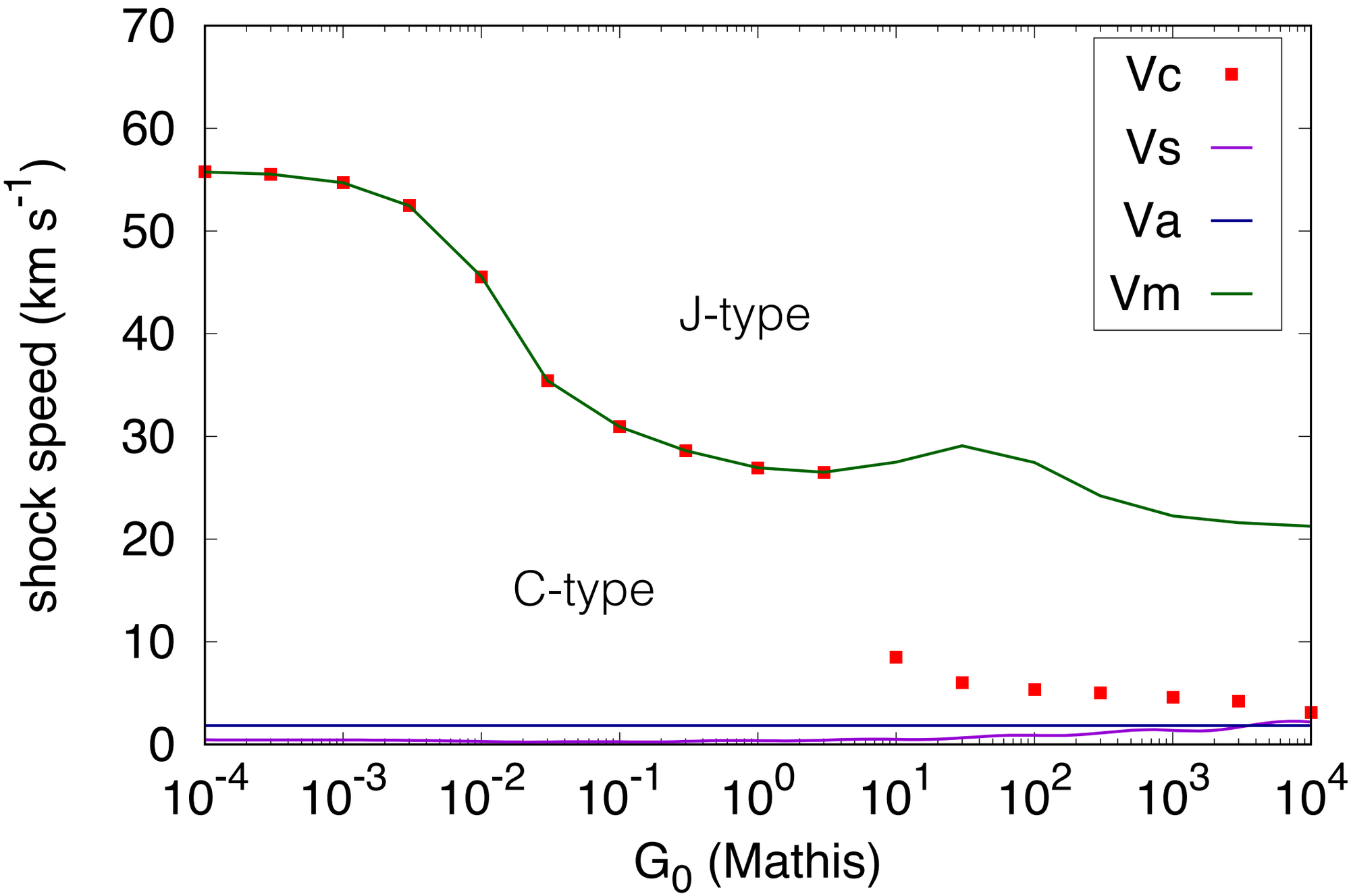
V_S = 25 km s^{-1}

n_H = 10^4 cm^{-3}

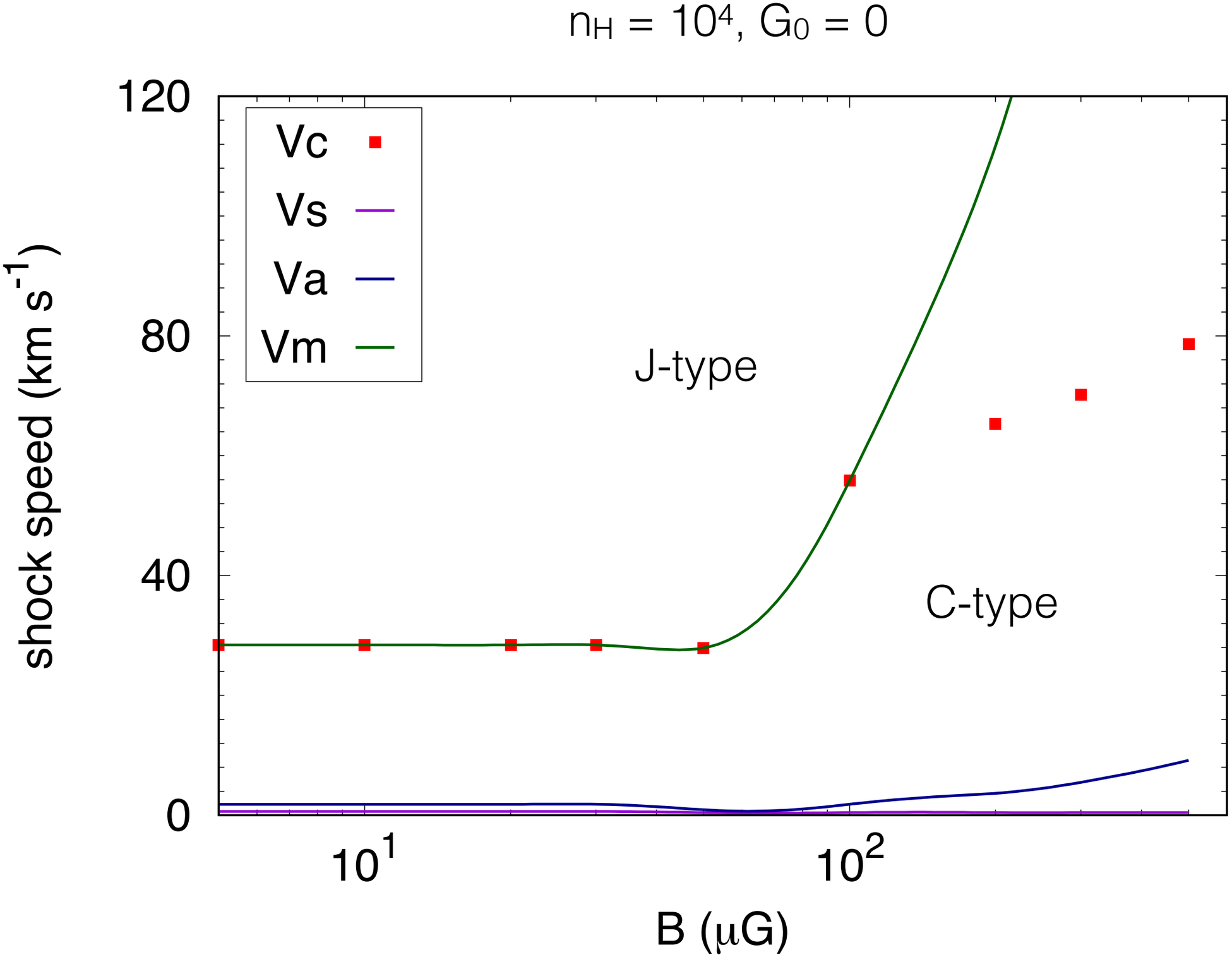
G_0 = 0

Influence of H2 on shocks

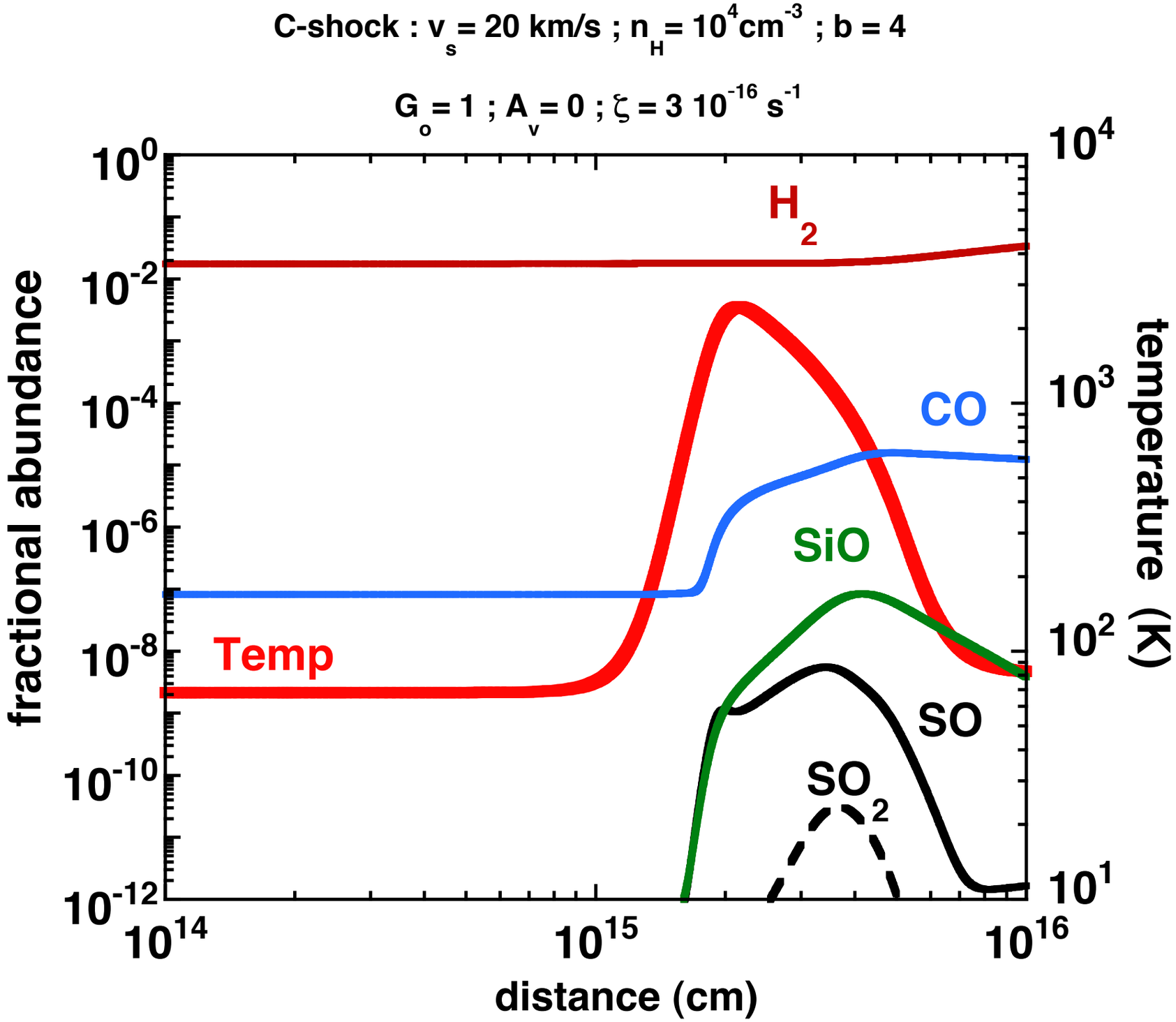
$n_H = 10^4$, b = 1



Influence of H2 on shocks

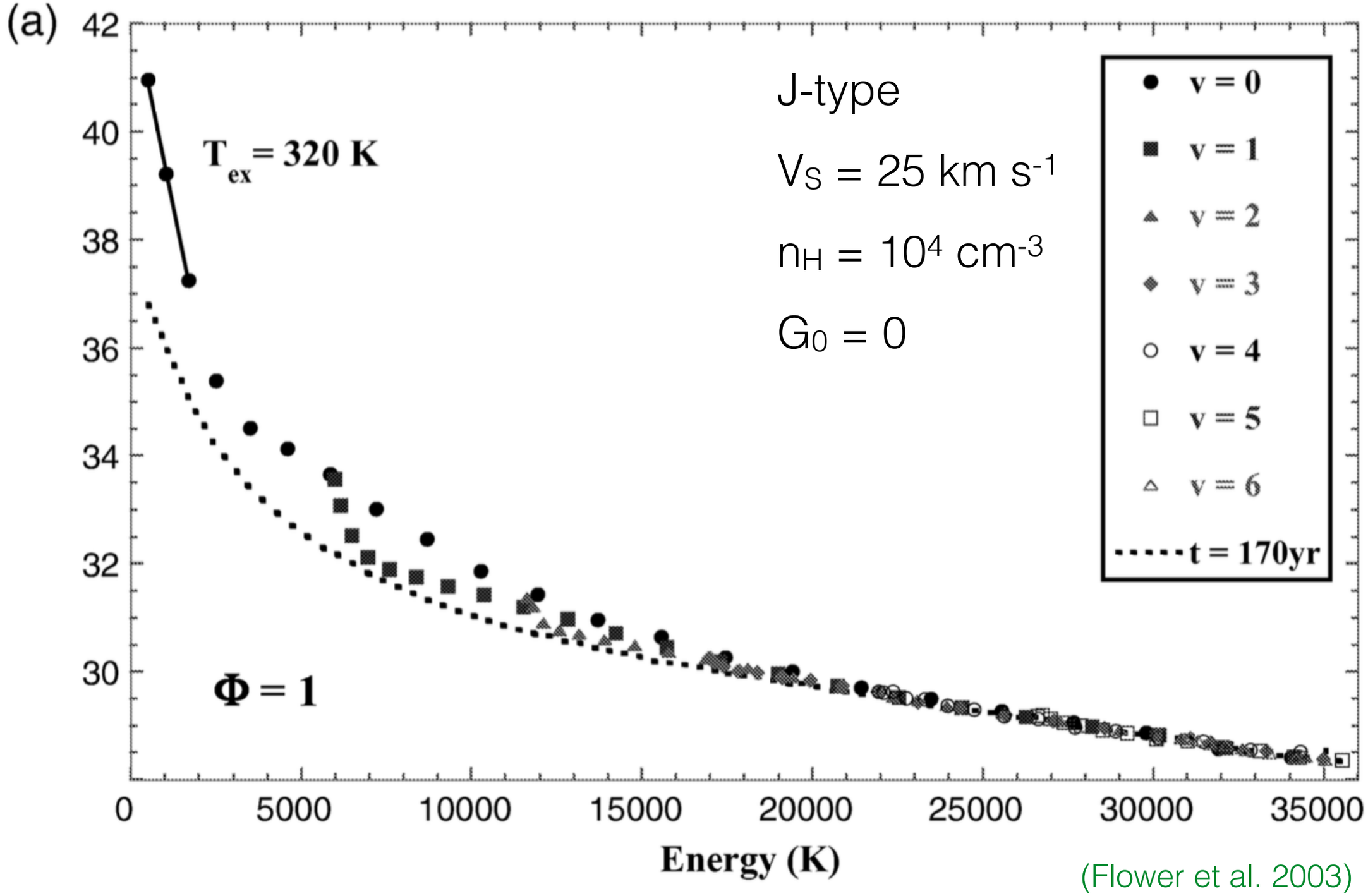


Influence of H2 on shocks



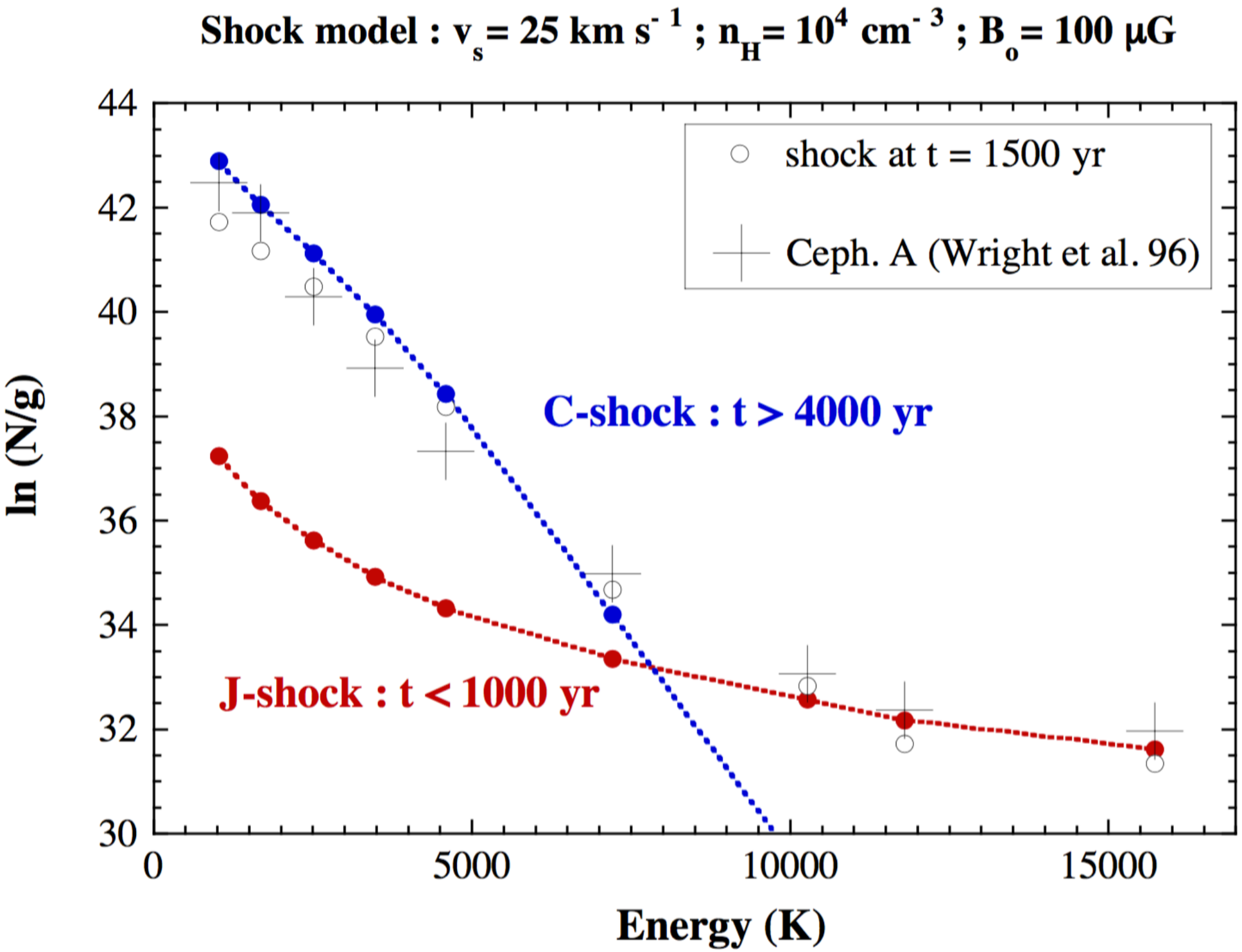
Influence of shocks on H_2

Influence of shocks on H2



(Flower et al. 2003)

Influence of shocks on H2



Ongoing investigations & future developments

Ongoing investigations

- Impact of UV excitation of H_2 on

  ✓ the shock dynamics

  ✓ H_2 emission (and other tracers)

- Formation and excitation of species in irradiated shocks, with low f(H_2)

- Application to observations

Ongoing investigations & future developments

Future developments

- shocks with radiative precursors
- improved formation of H2
  - ✓ ER and LH
  - ✓ impact of dust distribution
  - ✓ more accurate timescales
- improved dust treatments