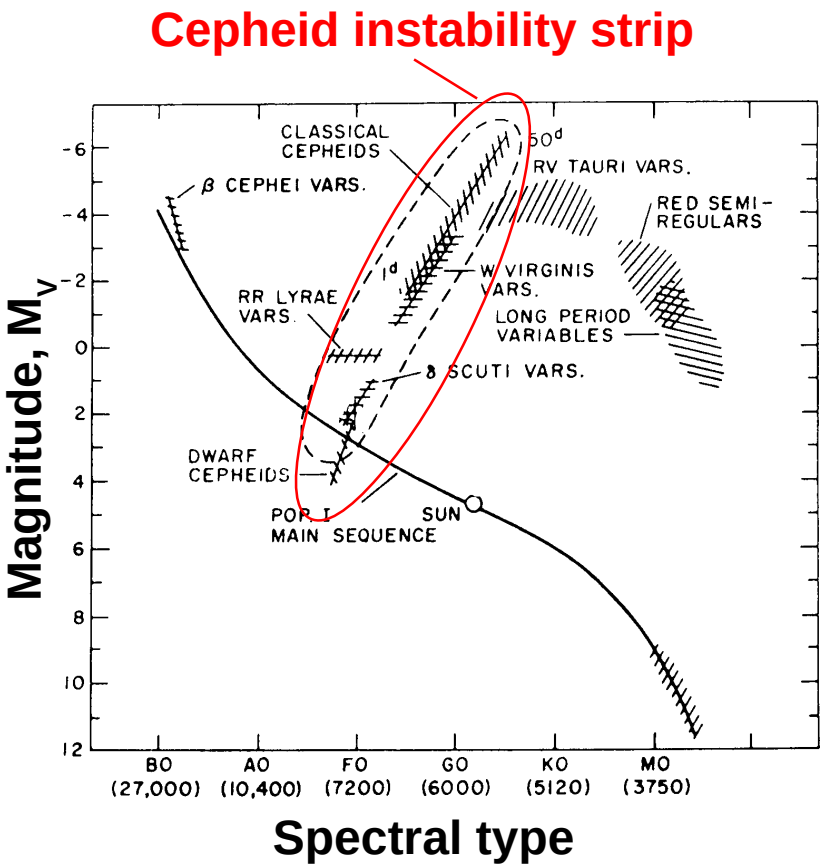
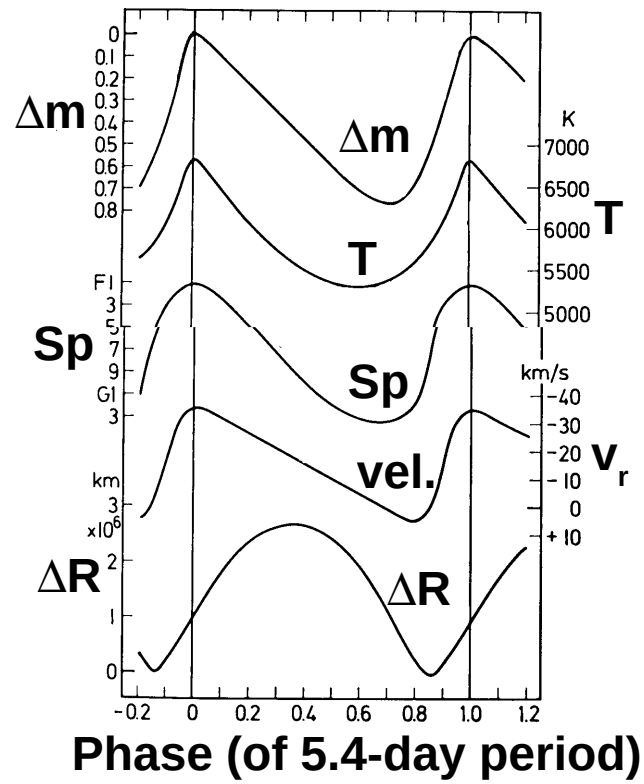
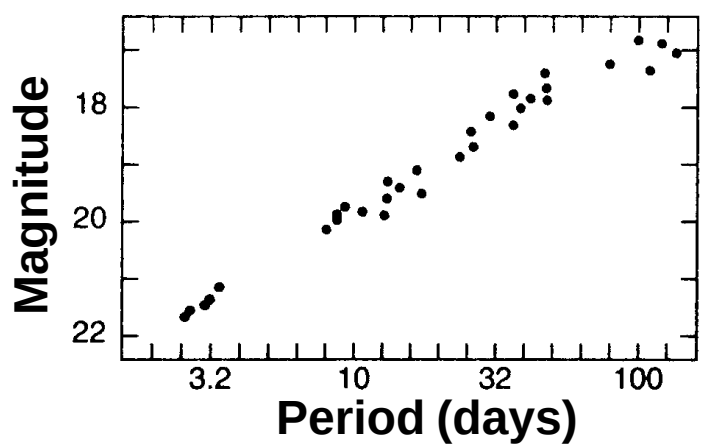
Opacities / Cepheid variables

Cepheid variables are stars whose intrinsic brightness varies periodically with time



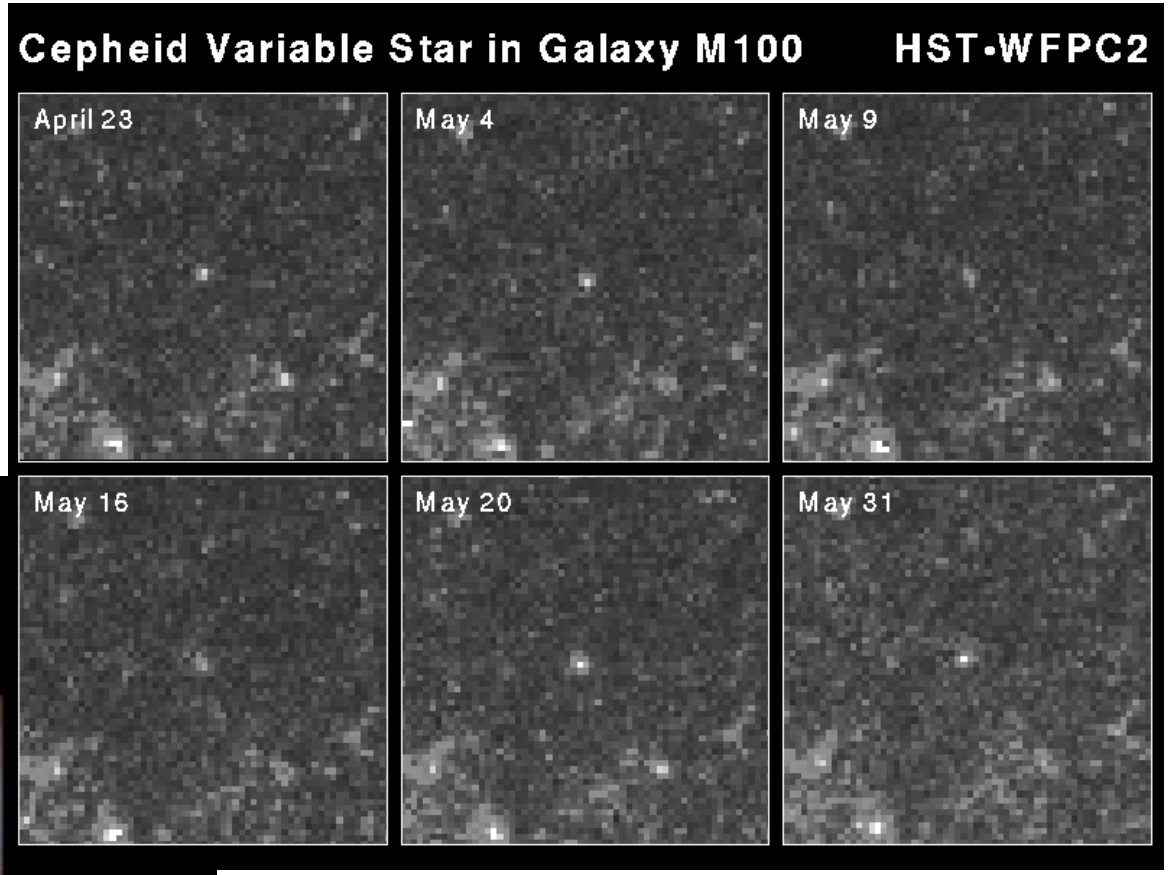
Bohm-Vitense, *Intro. to Stellar Astrophys.* (1989)



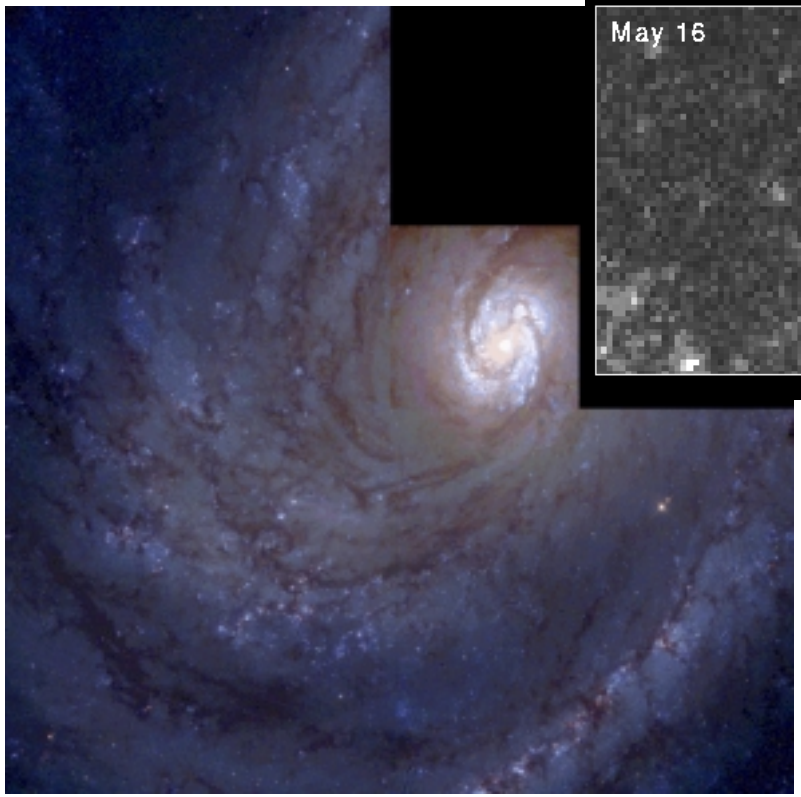


- Period ~ size ~ intrinsic brightness
- "Standard candle" = dist. indicator

An example Cepheid variable is seen in M100

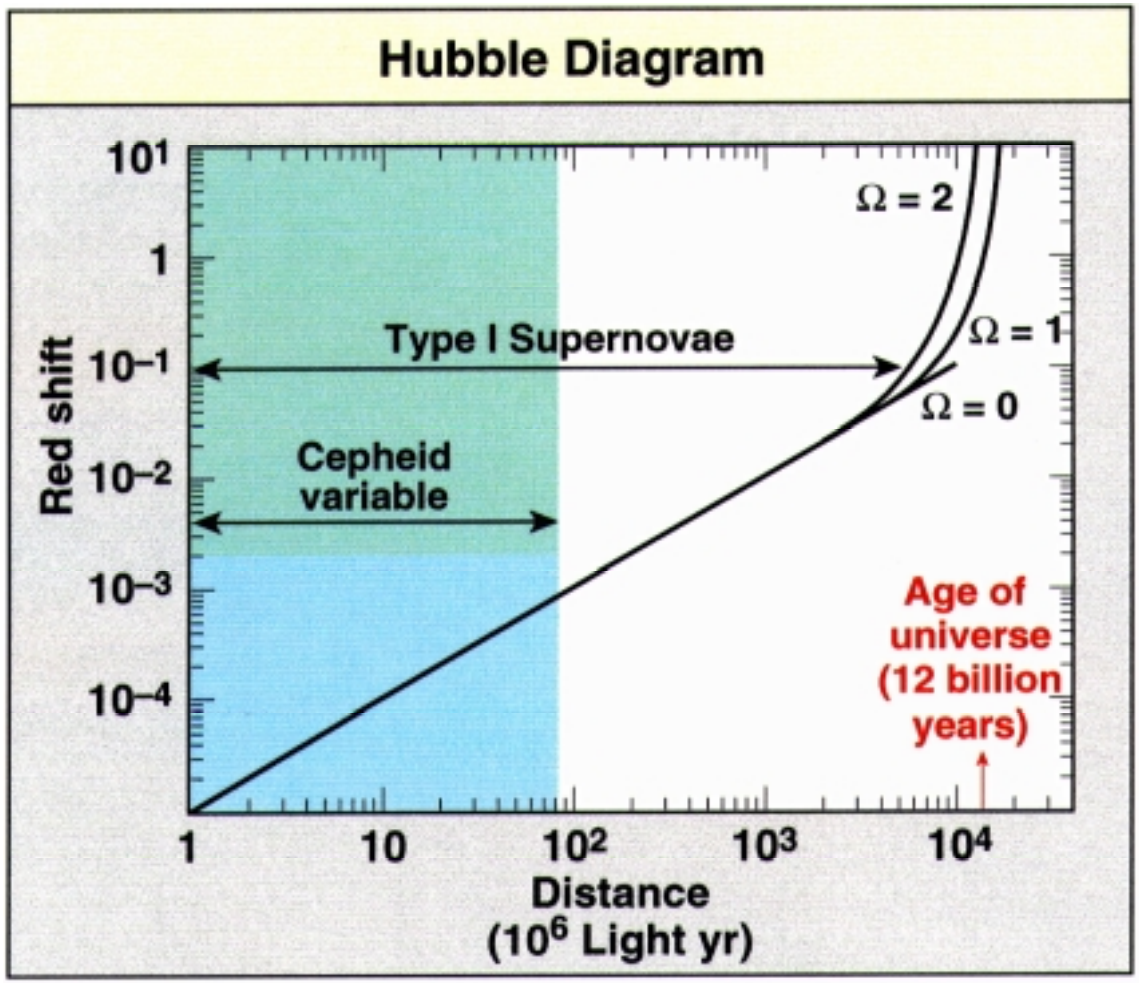


Galaxy M100,
HST - WFPC2



Cepheids_example.vg

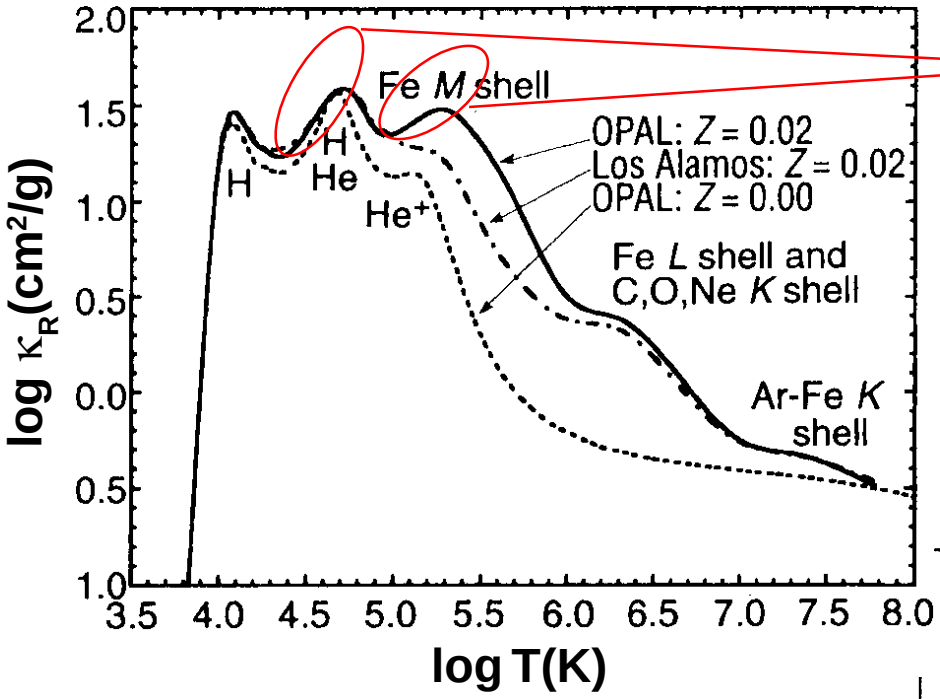
Cepheid variables are the most accurate distance indicators, and establish H_o in the neaby universe



P01078-pts-u-002

- **Opacities are an essential ingredient to understanding Cepheid variables**

Cepheid variables occur due to a global instability in the star

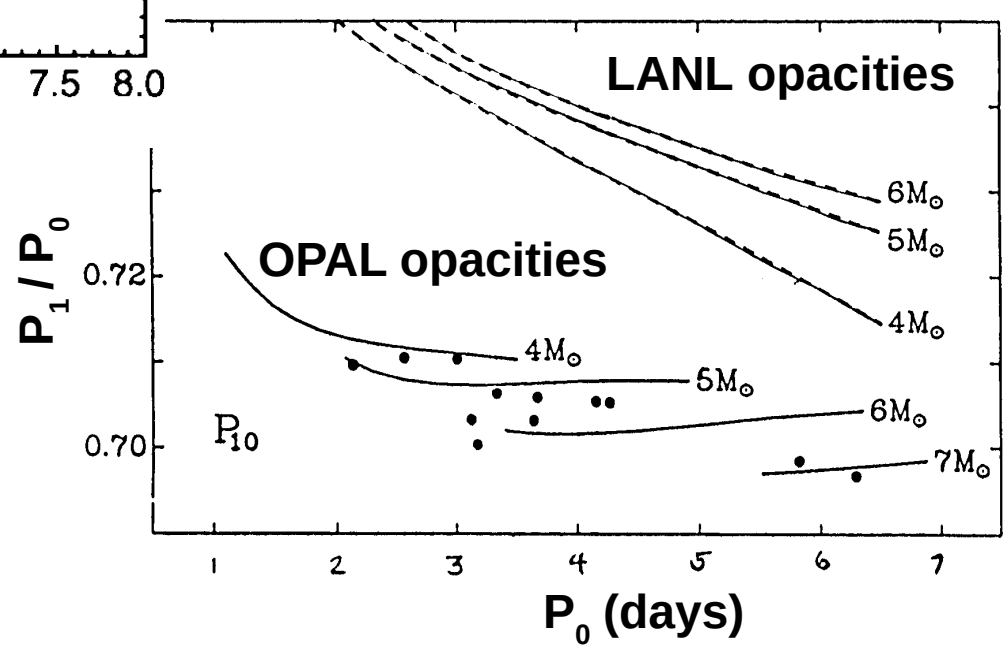


Rogers & Iglesias,
Science 263, 50 (1994)

Each bump causes a dκ/dT, which can lead to pulsation

- **The "beat Cepheids" are very sensitive to the opacity of Fe**

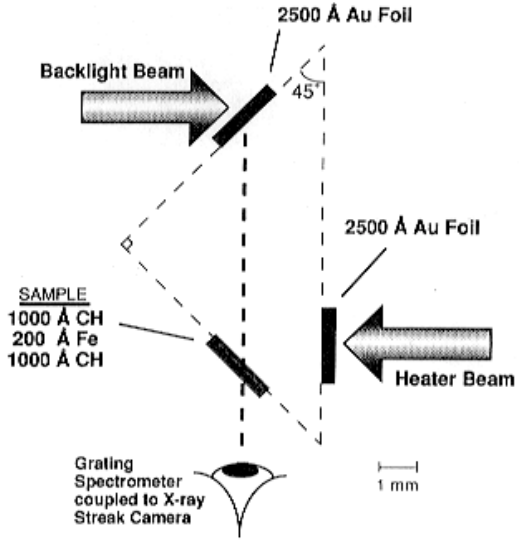
Moskalik *et al.*,
Ap. J 385, 685 (1992)

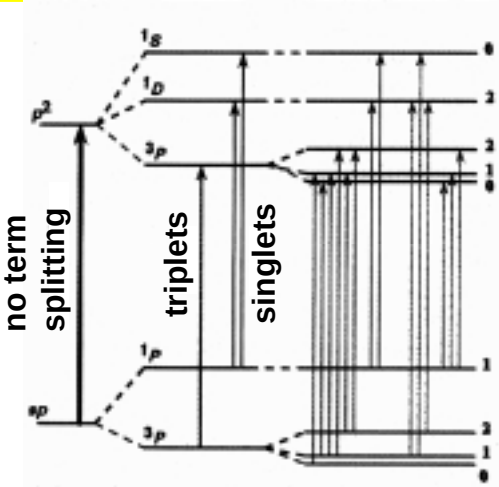


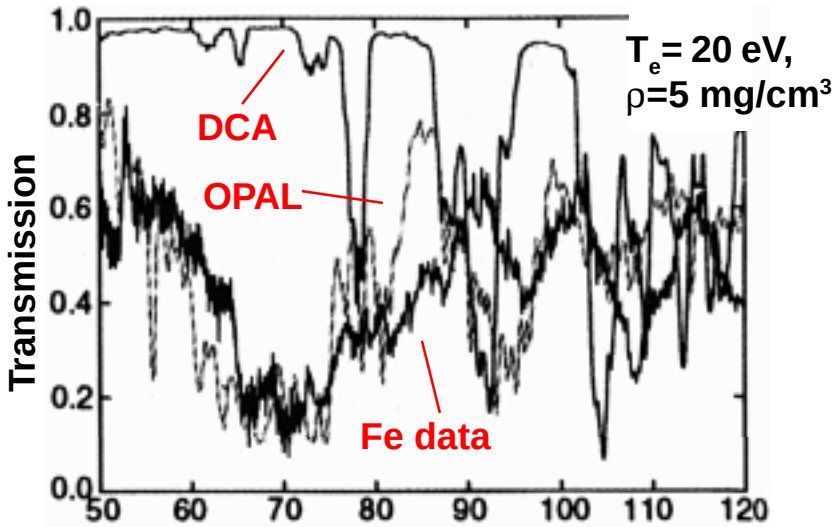
- **The "opacity problem" was solved through experiments**

Cepheid_1.vg

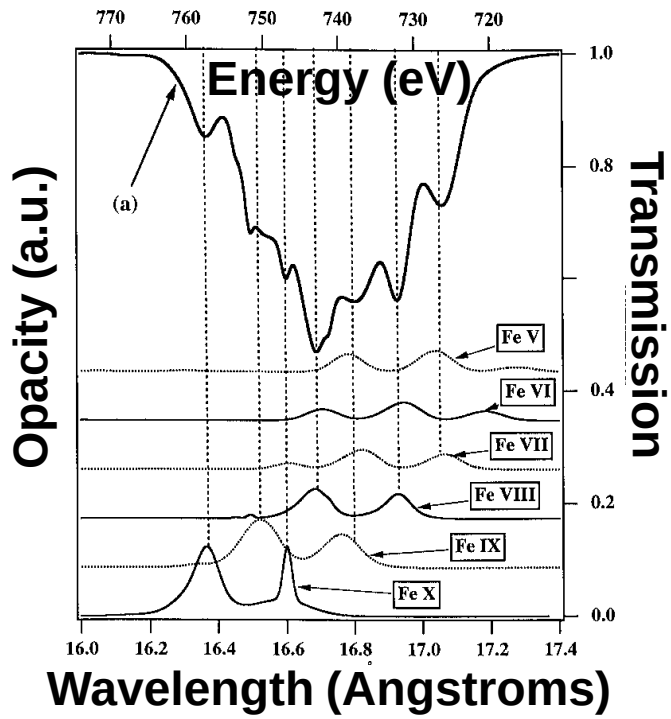
Experiments on the Nova and LULI lasers have tested the opacity modeling for iron







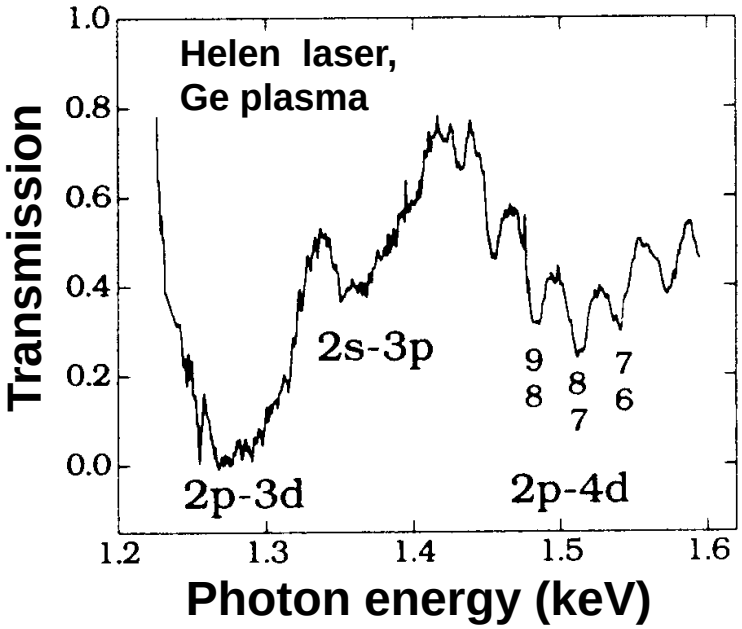
Rogers & Iglesias, Science 263, 50 (1994)



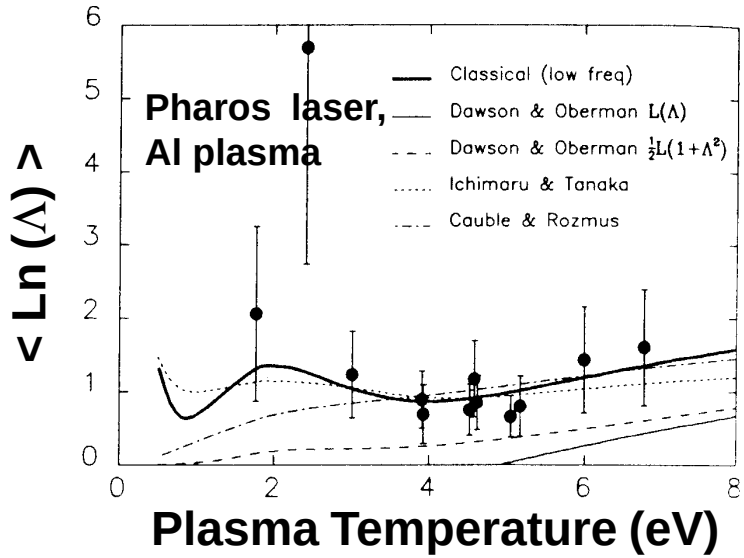
Chenais-Popovic *et al.*, in press, Ap. J. Suppl. (Apr. 2000)

Opacity_experiments.vg

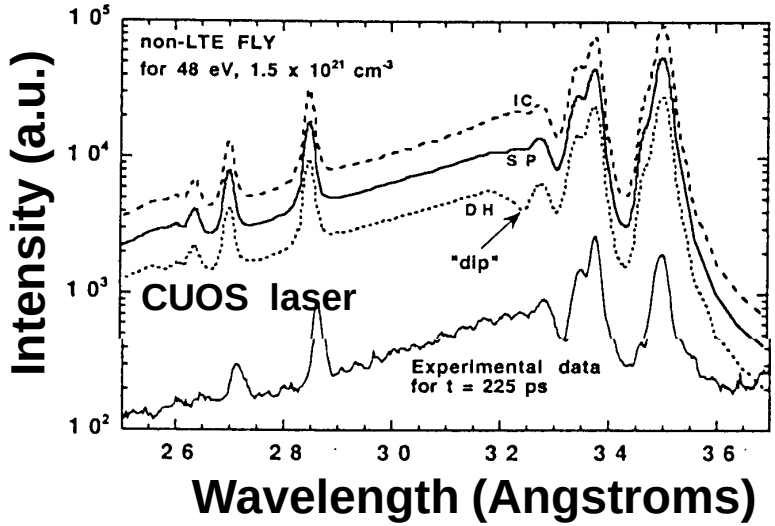
Opacity experiments relevant to astrophysics have also been conducted on the Helen, Pharos, and CUOS lasers



Foster *et al.*,
Phys. Rev. Lett. 67, 3255 (1991)



Mostovych *et al.*,
Phys. Rev. Lett. 66, 612 (1991)



Umstadter *et al.*, in press,
Ap. J. Suppl. (Apr. 2000)