Explosions to Observables: Three Views of Photon Transport in Supernovae

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Supernovae vs. Stars

- Extreme low density
- Rapid expansion, homologous expansion
- Lack bound-free, free-free opacity (esp. type I)
- Electron scattering and lines dominate
- Low total optical depth, (no true photosphere)

Supernova Power

- Thermal (shock heating of envelope)
- Circumstellar (shock heating of CSM)
- Radioactivity (decay and deposition of Ni-56)
    - gamma-rays scatter off electrons, deposit energy

Photon POV

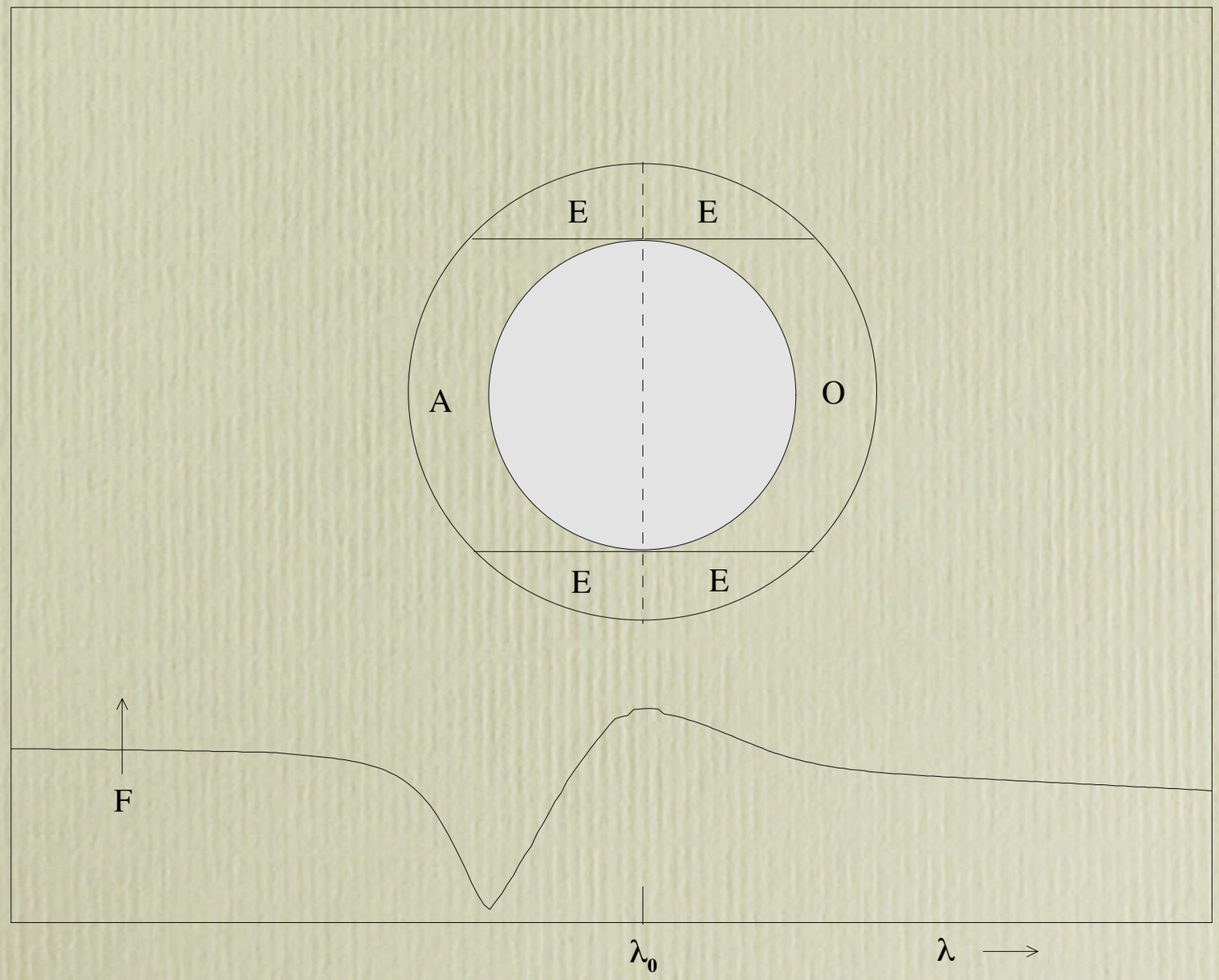
- Photon escape
- Sobolev Opacity
- Monte Carlo methods

Fluid POV

- Heating and cooling
- Excitation, ionization, recombination,...
- Co-moving transport

Observers POV

- Lab frame transport
- Line formation

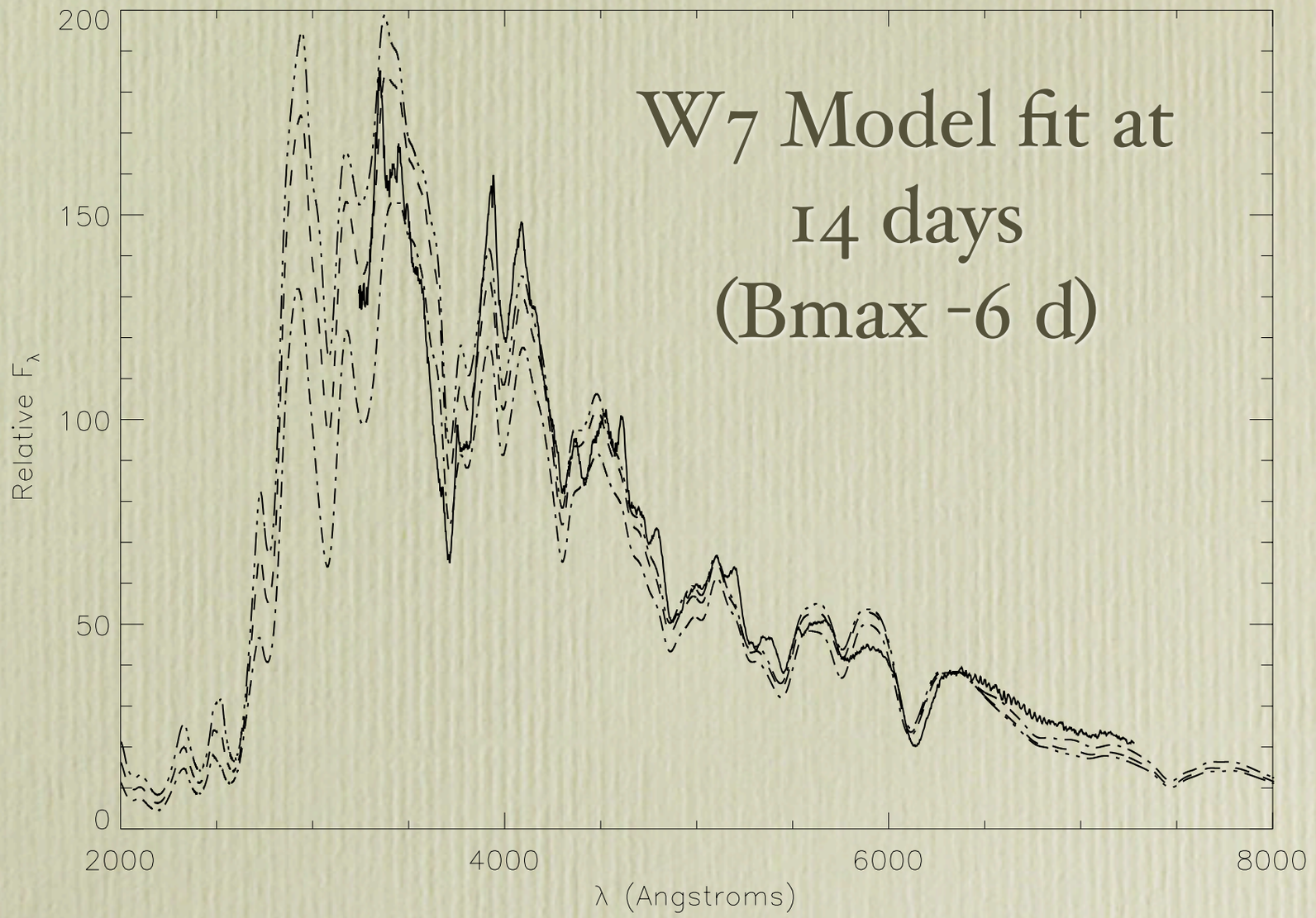


K. Hatano, 2000

Modeling Spectra

- Inputs:
  - Observed spectrum and age
  - Density structure (exp., power, hydro.)
  - Composition (uniform, parameterized, hydro
  - Luminosity (effective temperature)

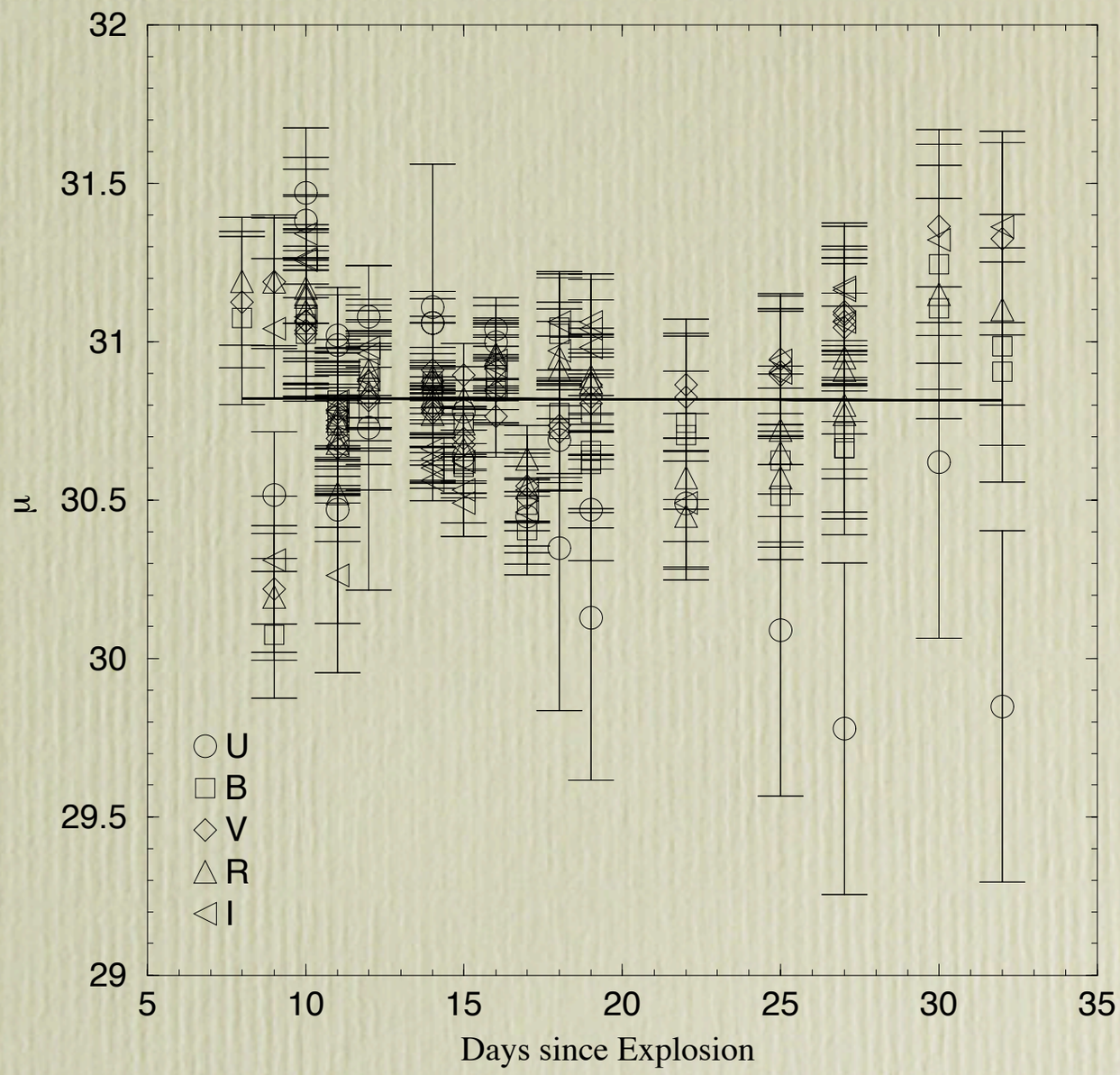
Example: SN1994D



Distance Measurement

Synthetic photometry compared to all observations

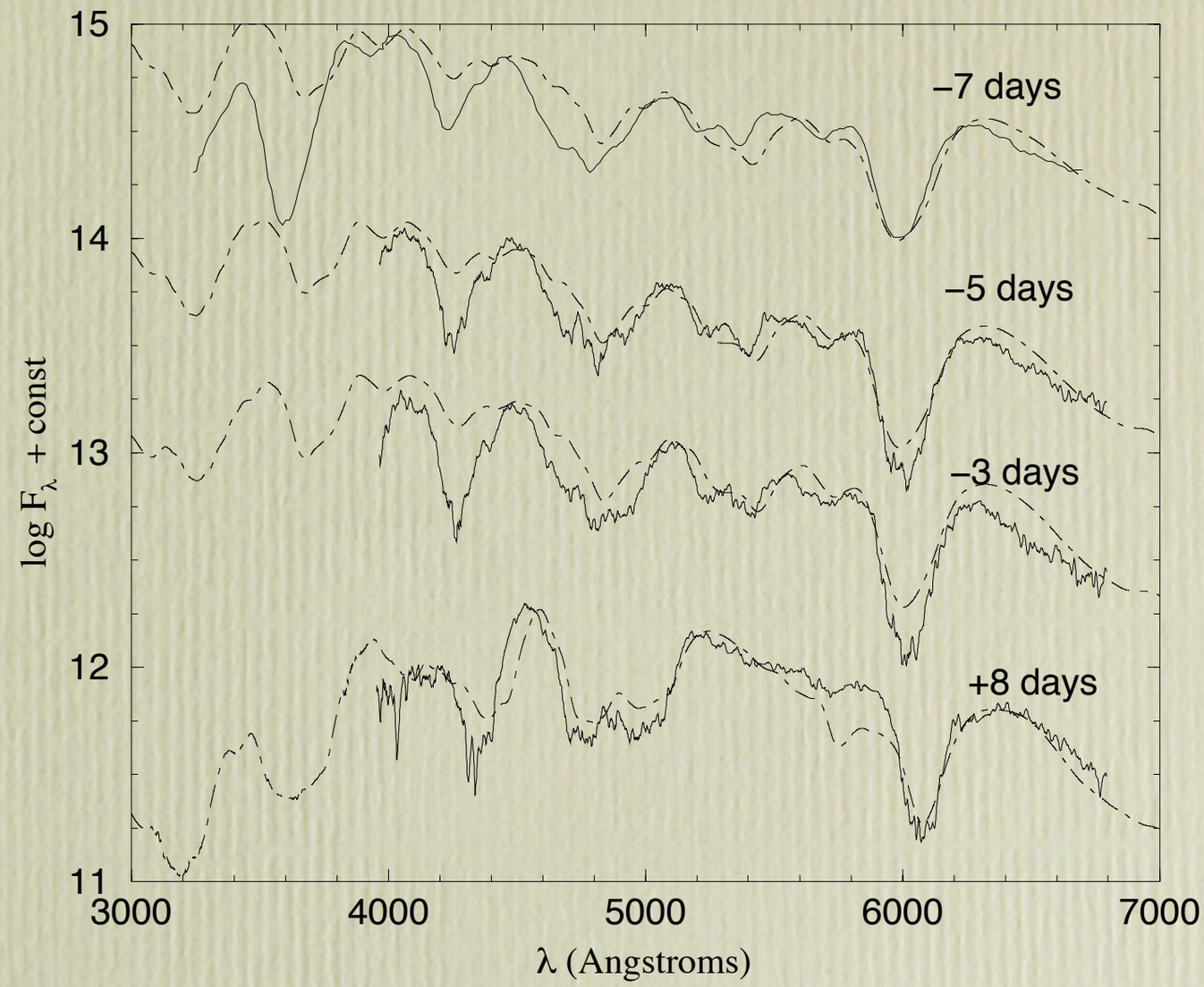
Distance compatible with other measurements



Example: SN1984A

Fits to Delayed Det. Model of Höflich et al.

(DD21c)



Light Curve Methods

- Multi-group RadHydro
  - Expansion opacity
- Monte Carlo LC
- TD-Stellar Atmosphere

Light Curves

- Time dependent stellar atmospheres problem
- Three Ingredients (alternative):
  - Time dependent transport (Instan. Transp.)
  - Thermal evolution (not a light curve!)
  - Time dependent non-LTE (Instan. Saha-B)

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