Polarized Line Profiles

as Diagnostics of Circumstellar Geometry

in Type IIn Supernovae

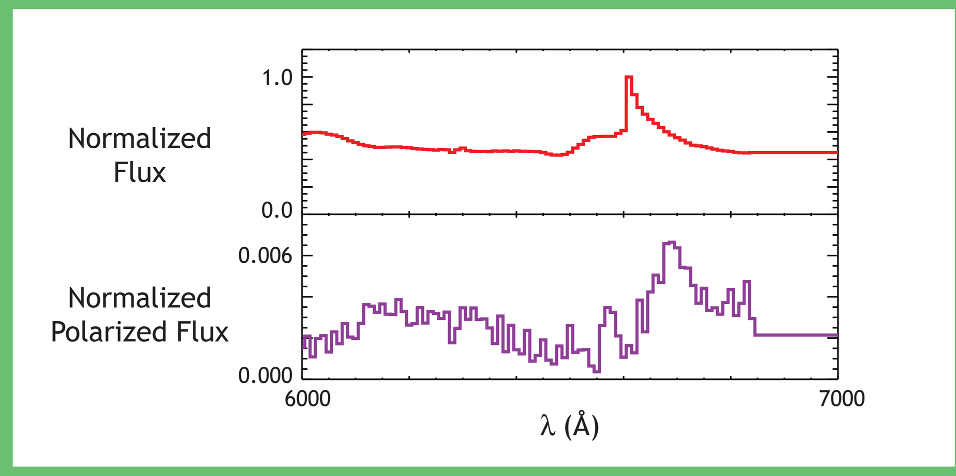
Jennifer L. Hoffman, Peter Nugent,
Douglas C. Leonard, & Alexei V. Filippenko

(UC Berkeley -- LBNL -- Caltech)

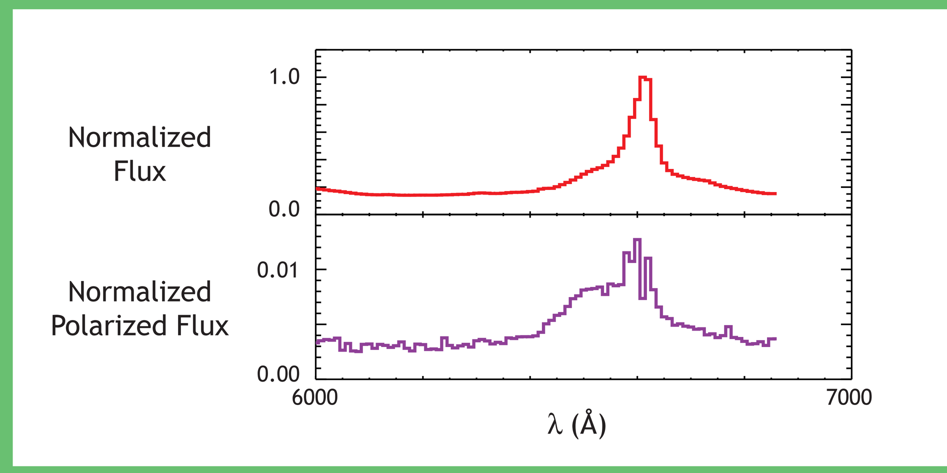
Supported by NSF Astronomy & Astrophysics Postdoctoral Fellowship AST-0302123
and the National Energy Research Scientific Computing Center, US DOE Contract # DE-AC03-76SF00098.

Flux and polarized flux spectra of supernovae of Type IIn show complex emission-line profiles. These are formed by intense interaction between the supernova ejecta and surrounding dense circumstellar material. We investigate how such line profiles can reveal the characteristics of the circumstellar shell.

SN 2000P, 13 days post-discovery

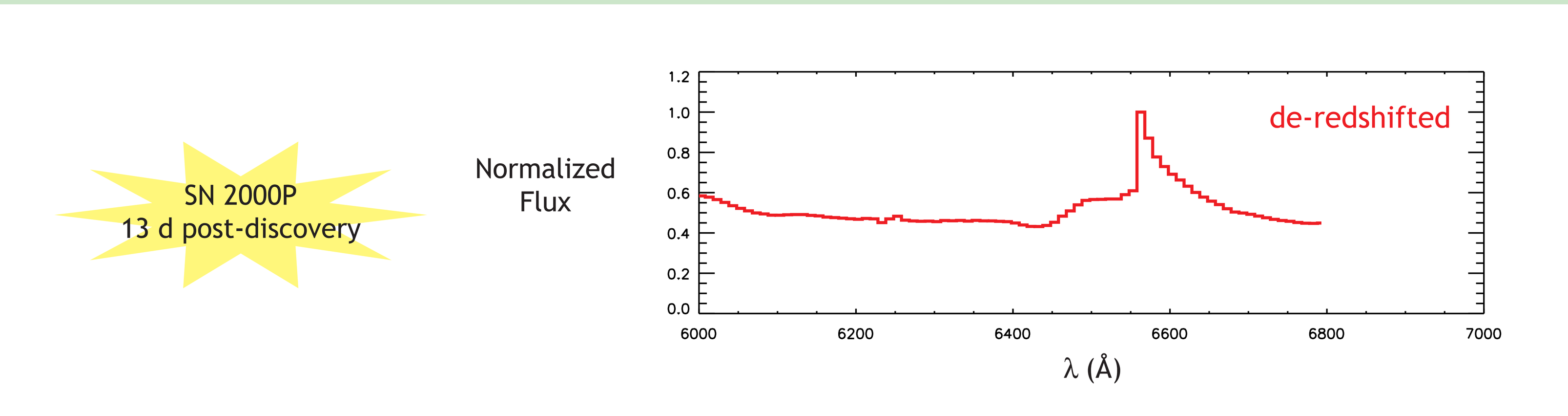


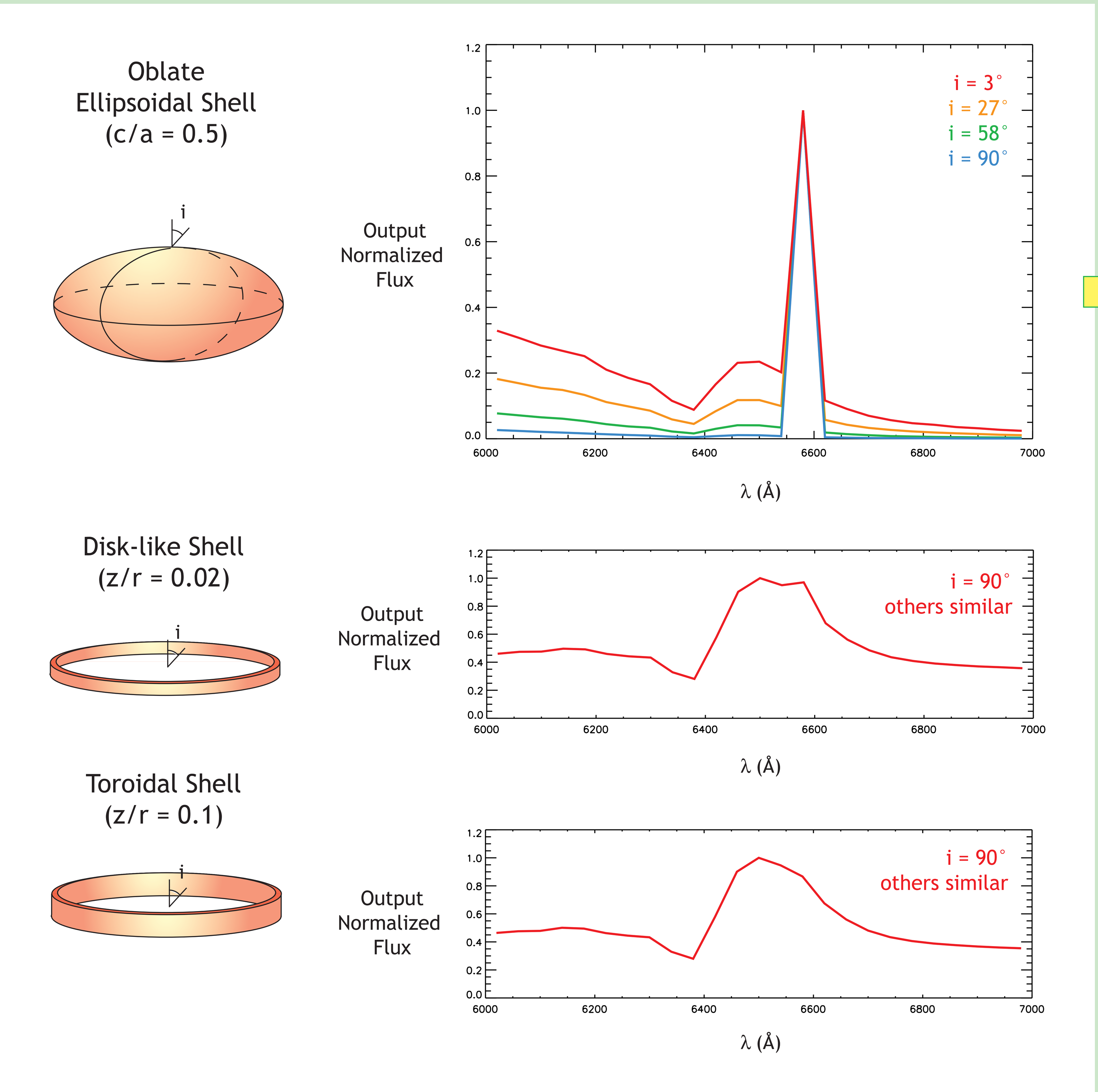
SN 1997eg, 43 days post-discovery



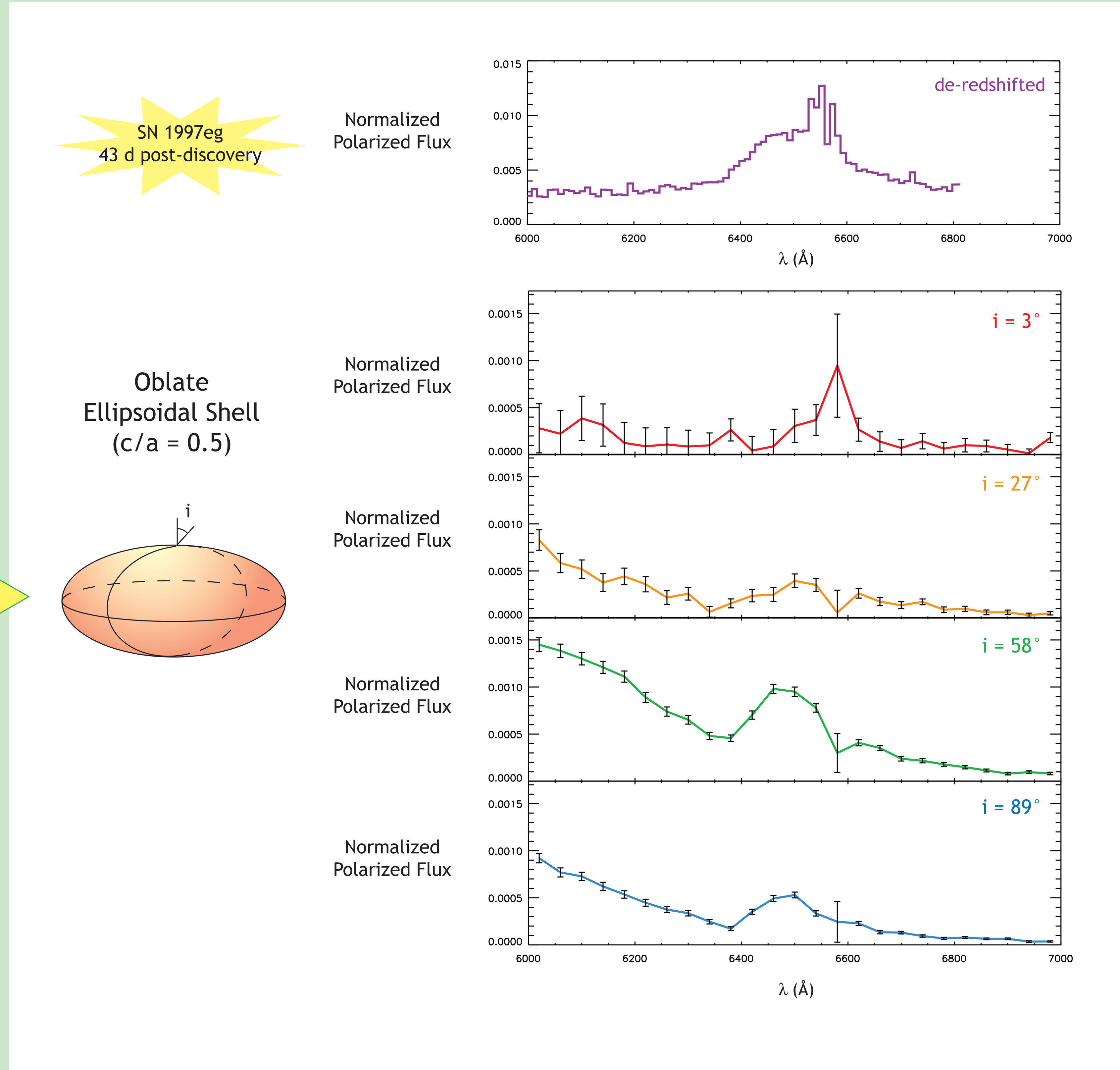
(see Leonard et al. 2000, Filippenko & Leonard 2003)

We use a Monte Carlo radiative transfer code to simulate an Hα profile from a Type II-P supernova photosphere interacting with stationary circumstellar hydrogen shells. The shells both absorb and emit Hα light; scattering is by electrons and resonance lines. In our initial models, large Hα "spikes" such as those seen in Type IIn spectra only arise from ellipsoidal shells, while the broader "shoulders" of the profile only arise from models with circumstellar optical depths less than 5 and temperatures between 15000K and 20000K. Models shown here have shell luminosities between 1/10 and 1/100 the photospheric luminosity.





But matching the flux does not necessarily mean matching the polarization! Models with very similar Hα flux profiles across viewing angles, such as this ellipsoidal model, may have very different polarized flux profiles depending on their orientation to the viewer. The results shown here suggest that SN 1997eg may be surrounded by an ellipsoidal shell that we view nearly pole-on. Our intent so far has been to explore the parameter space that may give rise to the observed effects. More robust anlysis will require quantitative simultaneous fitting of the flux and polarized flux profiles.



The most luminous supernova explosions, sometimes reaching Mv ~ -21, belong to the Type IIn subclass. Using radiative transfer models to study the interaction between ejecta and circumstellar material in these supernovae can yield clues to the nature of Type IIn progenitors, their mass loss history, and the processes that drive these powerful astrophysical engines.

For more details, see http://grammai.org/jhoffman/sne .