Reconstructing Supernova CSM with Polarized Line Profiles

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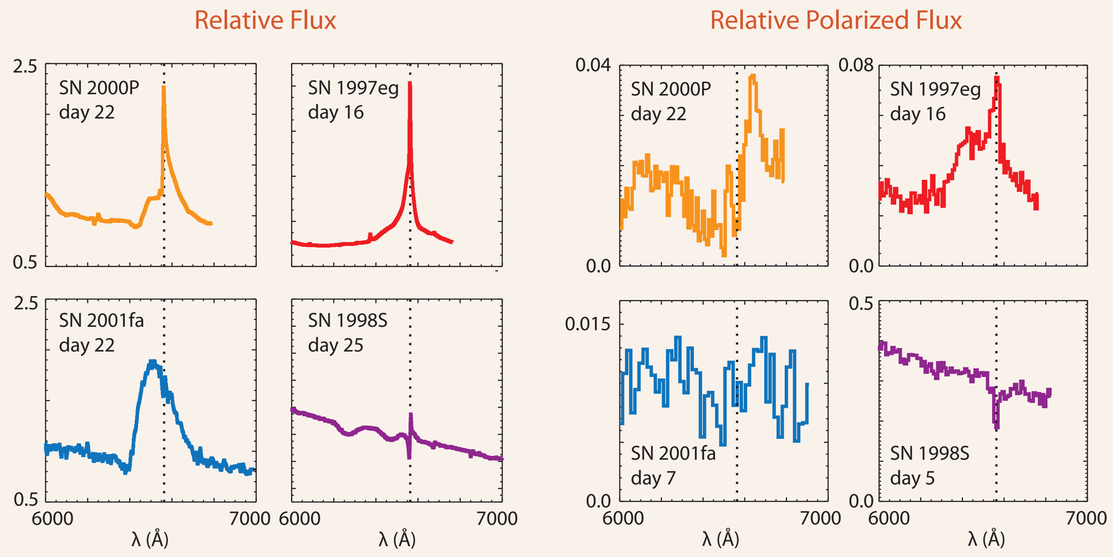
1. Hα emission line profiles in direct and polarized light vary widely among SNe IIn, but their variations are not necessarily correlated.

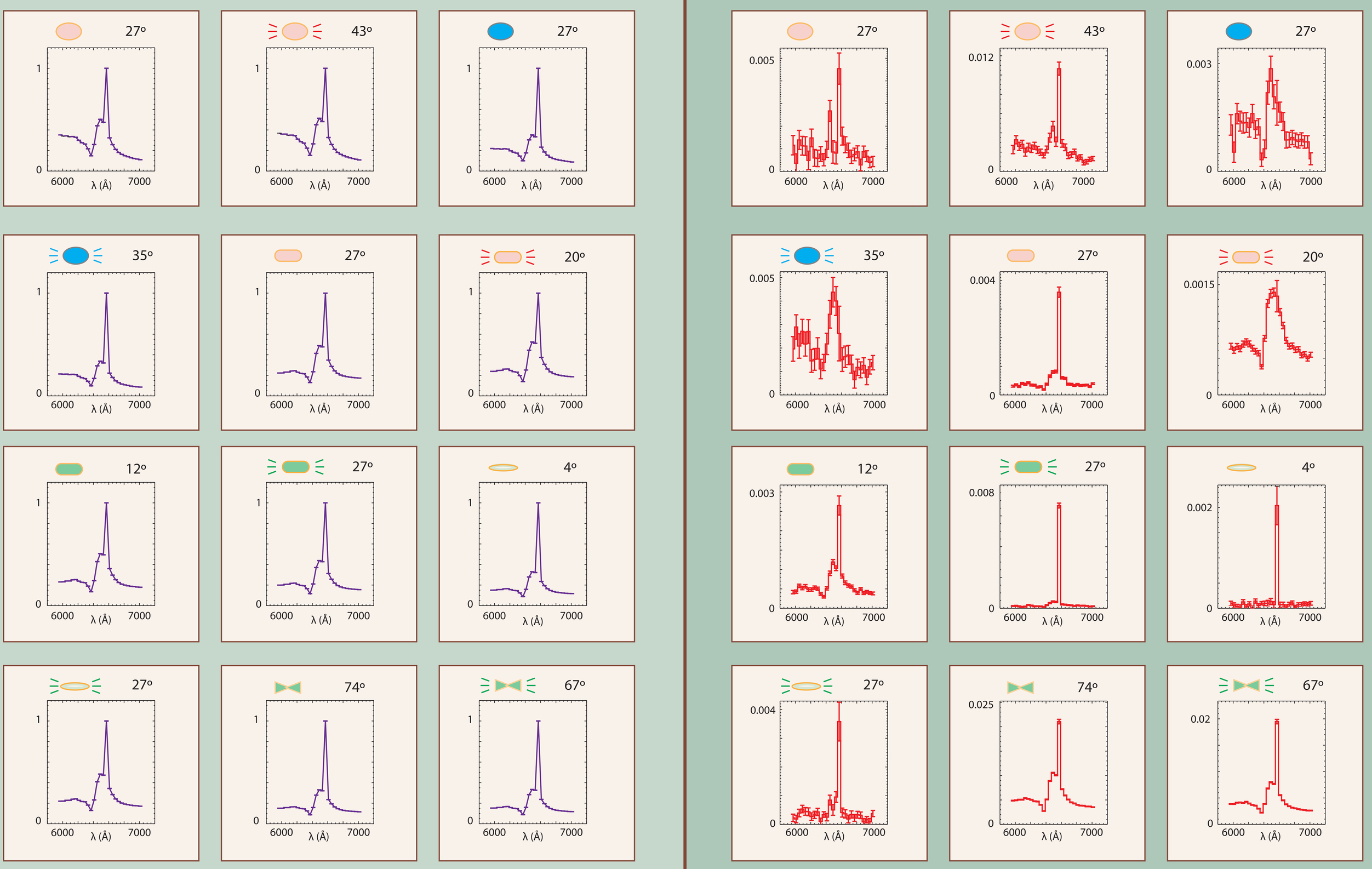
Differing line profiles reflect differing characteristics of the circumstellar material in interacting SNe, which in turn probe the mass-loss history of IIn and other progenitors. Hα line profiles in the flux spectrum are well studied, but the corresponding profiles in polarized light have not been systematically investigated. Polarized line profiles are often degenerate with line profiles in the flux spectrum, and thus provide an extra dimension of information. With the help of radiative transfer modeling, polarized line profiles can serve as a diagnostic of CSM geometry, temperature, density, and structure.



Hα line profiles of several SNe IIn at comparable epochs.
Both the flux and the polarized flux profiles vary widely between objects.

2. Models demonstrate how polarized line profiles can differ widely for similar total flux shapes.

The simulated line profiles below were produced by the radiative transfer code *SLIP* (Hoffman 2007, RvMxA&A v. 30). Hα line photons are emitted with a P Cygni line shape from a central source (the SN "ejecta") and interact with pure hydrogen CSM with a range of geometries, optical depths, and temperatures. Photons may also arise from the CSM and from a hot interior "shock" region. No CSM expansion is yet included in the code.



ellipsoidal CSM
toroidal CSM
"ring-like" CSM
"disk-like" CSM

CSM emits
CSM does not emit
bright "shock" region
dim "shock" region

T (CSM) = 10,000 K
T (CSM) = 20,000 K
T (CSM) = 50,000 K

τ (CSM) = 0.5
τ (CSM) = 1
τ (CSM) = 2

Degrees indicate viewing angle (90° = edge-on)

3. Polarized emission lines in SNe IIn thus carry detailed information about the CSM that is not evident from the flux spectrum.

Line polarization effects are often interpreted simply as signatures of aspherical CSM configurations. These models show that polarized line profiles contain a great deal of detailed information about the specific properties of the CSM that has so far remained untapped. Ongoing work in this arena will reveal many practical spectropolarimetric diagnostics.

SNe IIn spectra are from Filippenko, private communication.
SN 1997eg data are from Hoffman et al. 2008, ApJ, 688, 1186.

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