Nebulae with wide Hα wings

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Source: SPM Kinematic Catalogue of Galactic PNe

López et al. 2012, RevMex 48, 3

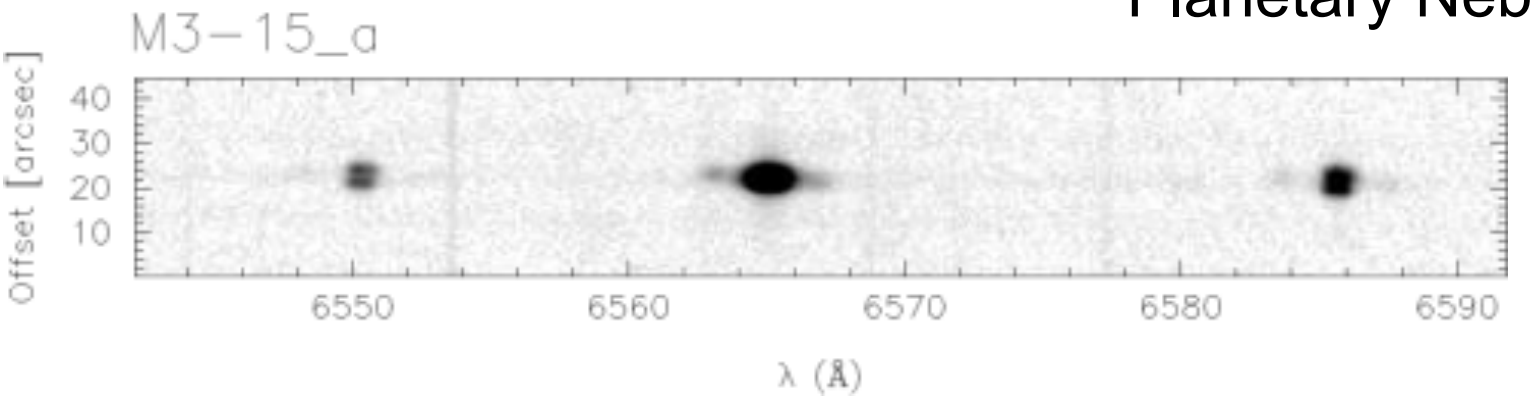
- Database of over 650 PNe, over 3000 spectra
- Long-slit, single order echelle spectra
- 5 and 11 km s^{-1} resolution
- Efficient tool to identify out of the ordinary PNe or non PNe
- Database allows to study groups from a broad perspective that gives an interpretative advantage

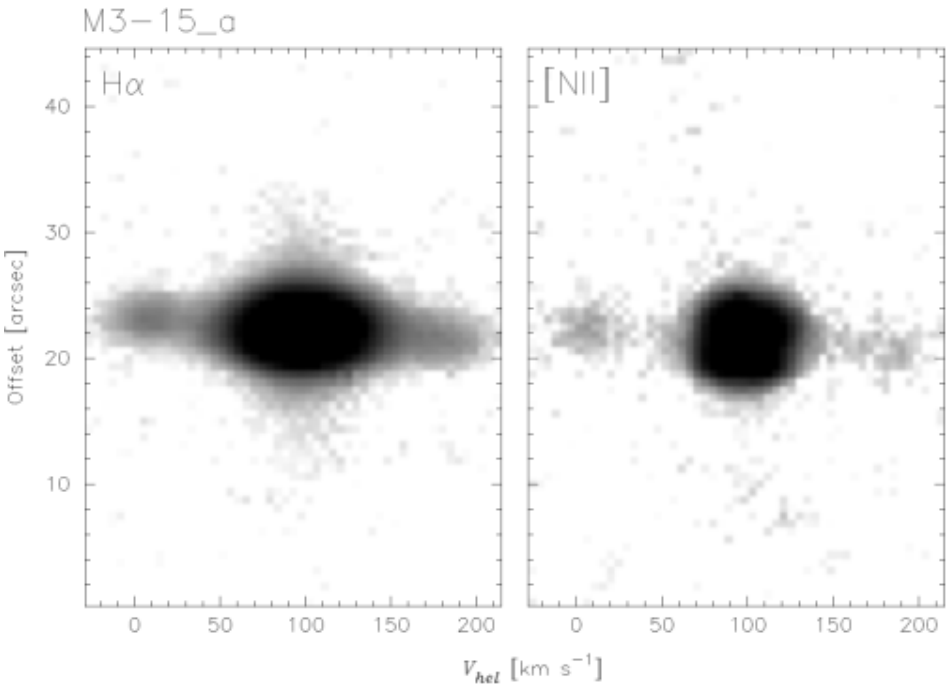
  (1 image = 1000 spectra = perspective)

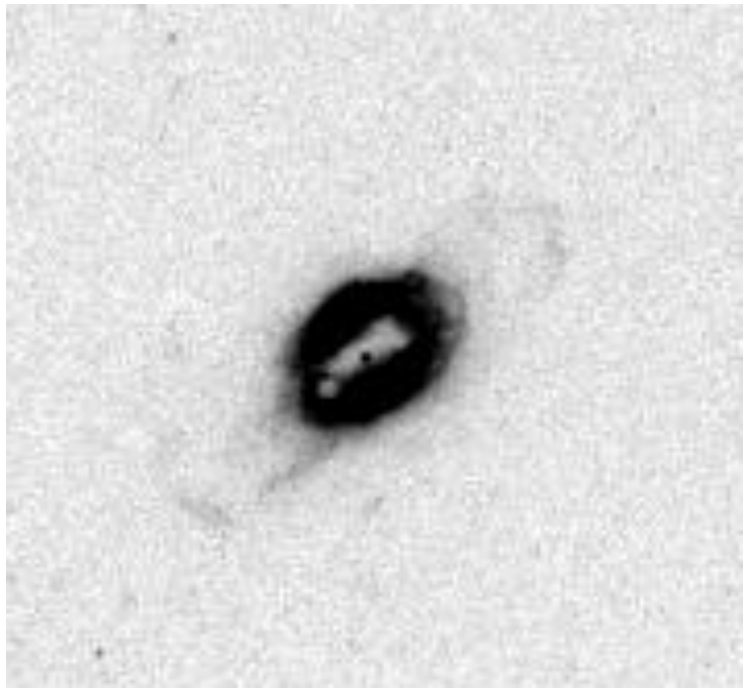
Why are these objects interesting?

- Pole-on bipolar outflows from PNe; allow to gauge the (close to) true outflow velocities
- Symbiotic D-type nebulae. Wide Hα wings, strong red continuum from late companion.
- Allow to identify out of the ordinary or misclassified PN among the PNe population.
- Young PNe with recent AGB/postAGB episodes of high mass-loss rates. Massive HI envelope produces Ly β scattered photons that emerge through Hα wings, as in symbiotics with dense shells.

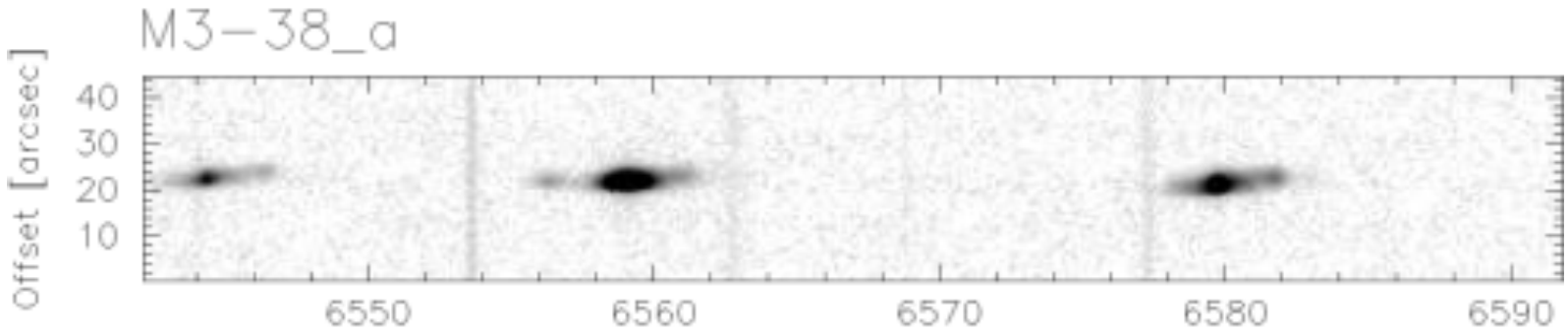
Planetary Nebulae

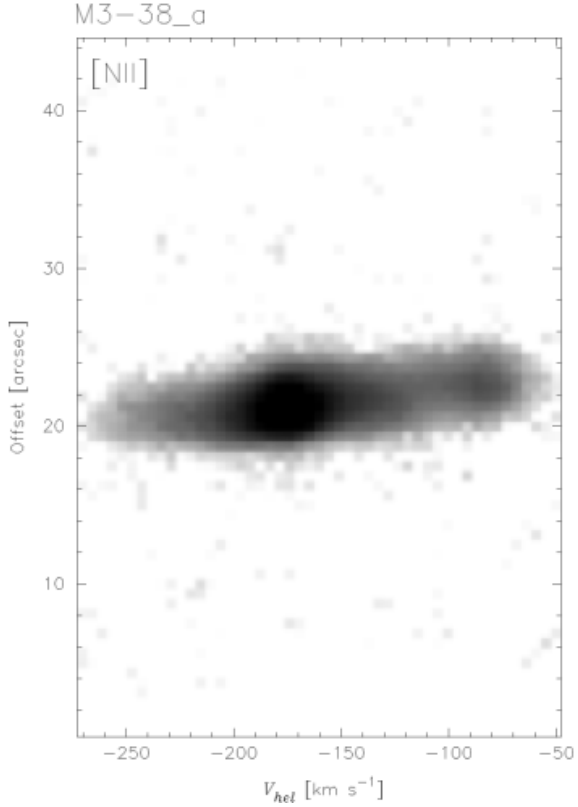


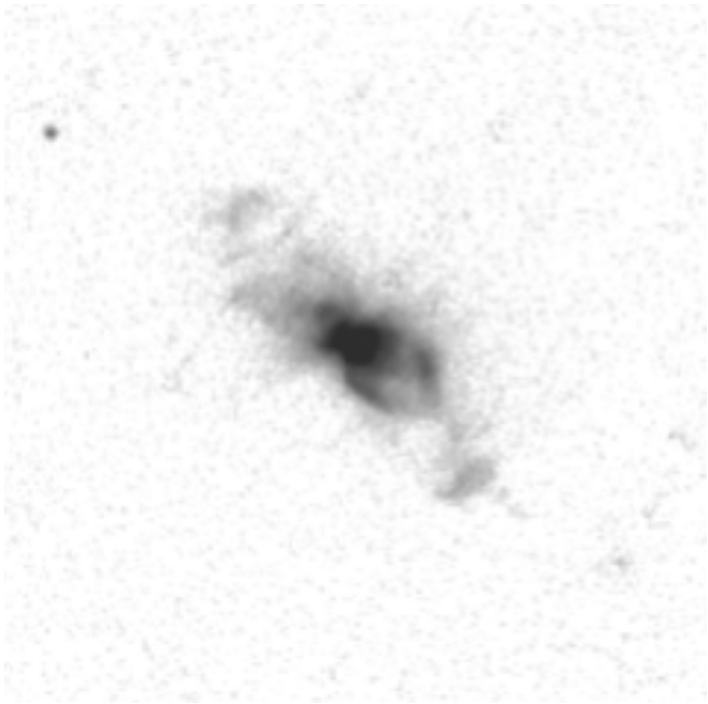




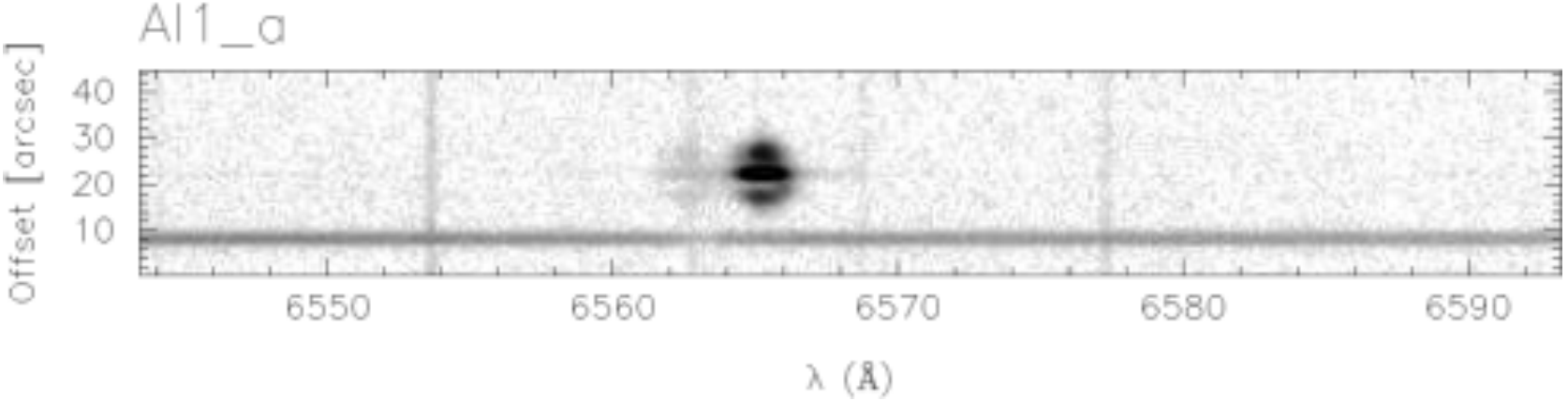
PN with WR-type nucleus. Bipolar outflow

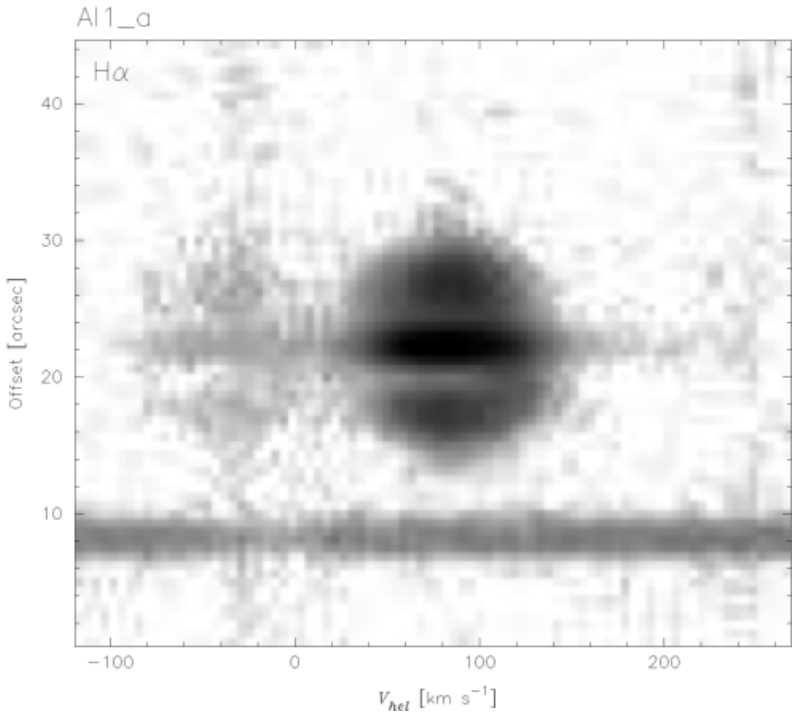


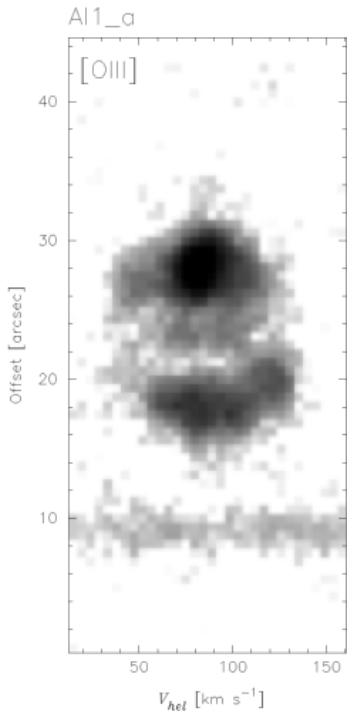




Young Bipolar PN

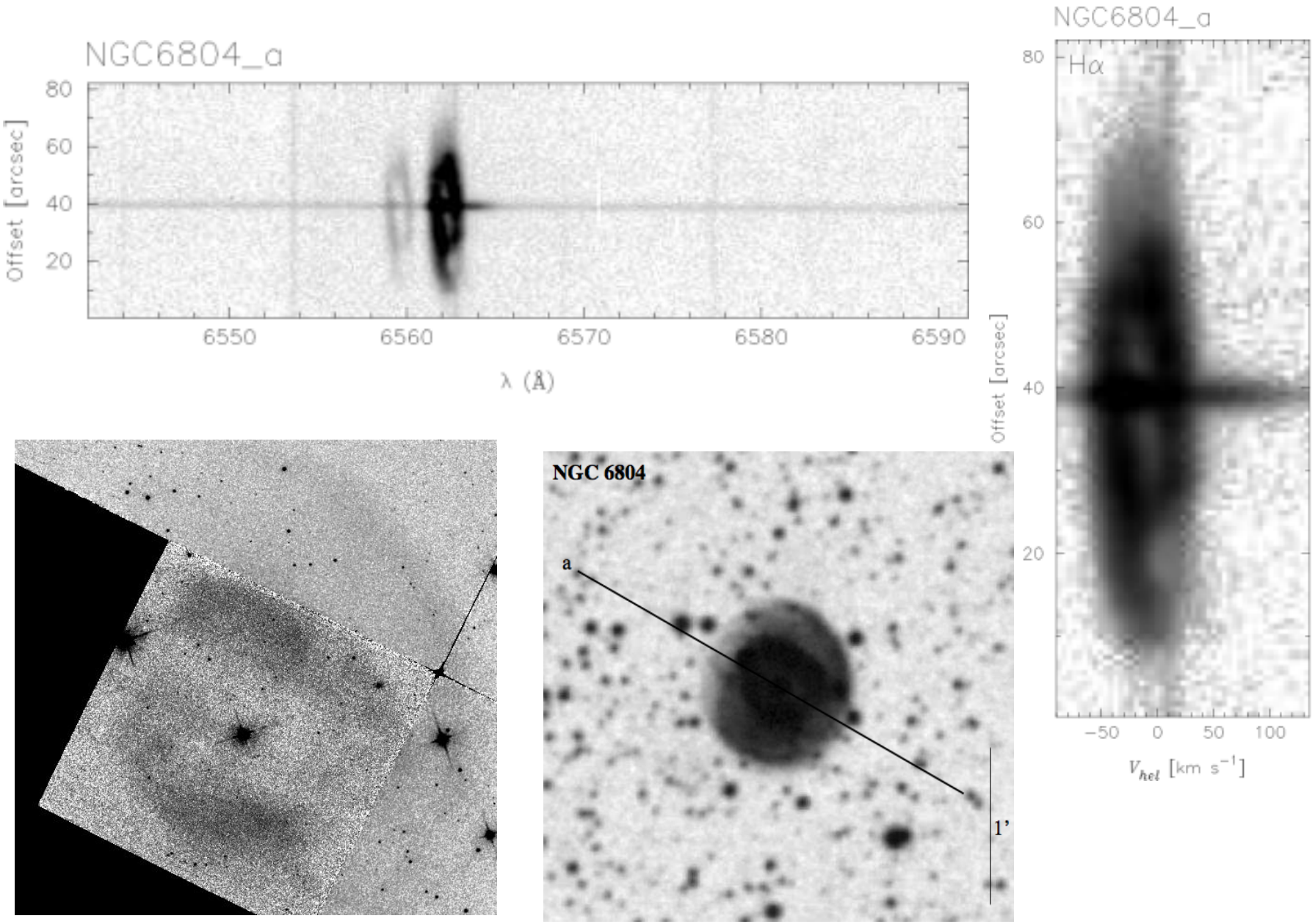




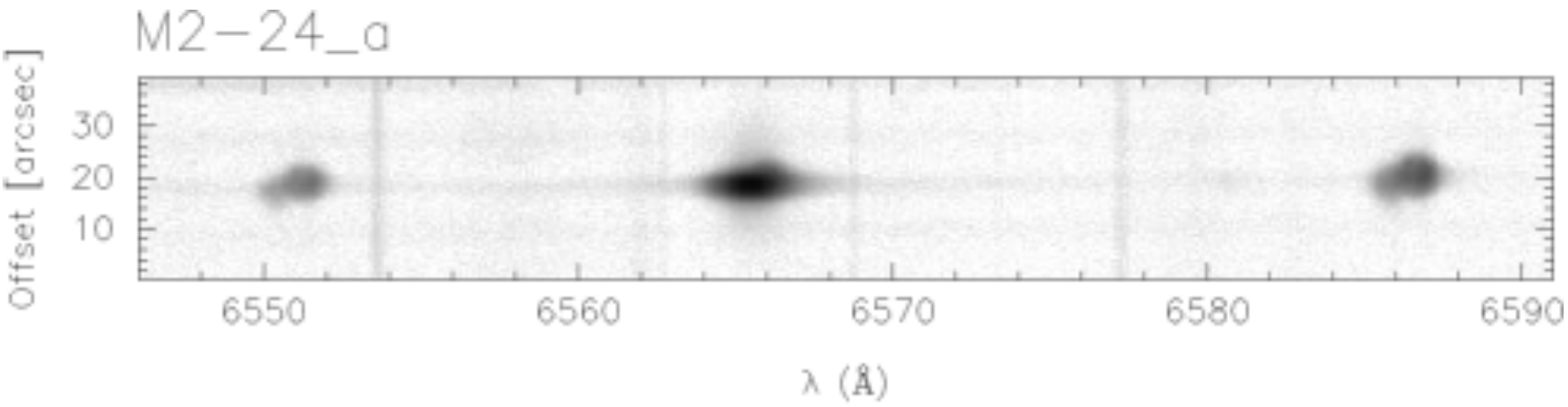


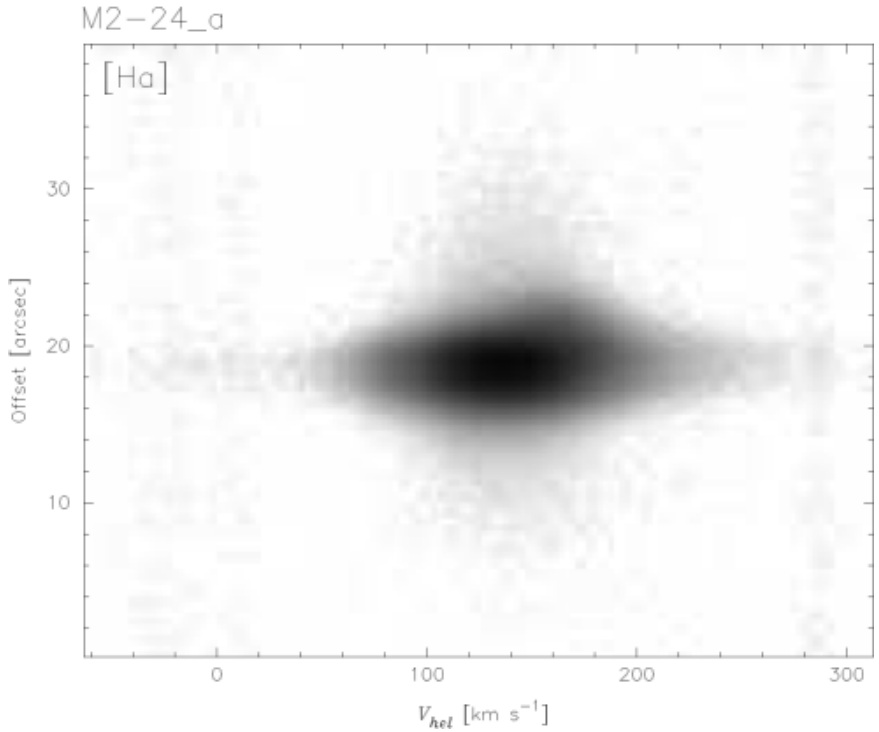
Notice wide wings present only in Hα, absent in [O III]

PN



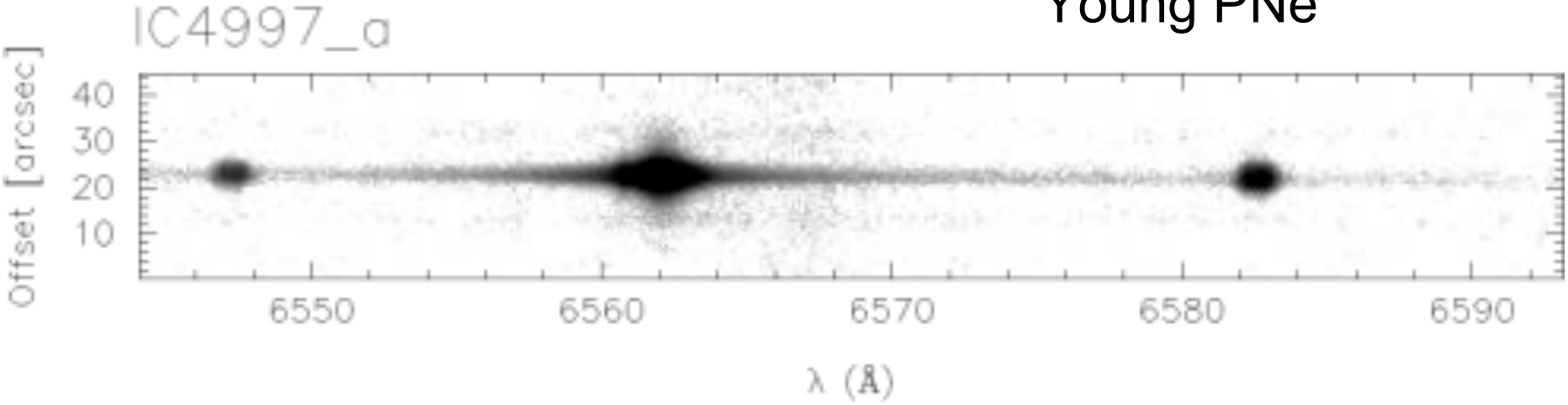
PN Possible debris/dust disk (Bíliková et al. 2012 ApJS 200:3)


M2−24_a
Offset [arcsec]
30
20
10
6550
6560
6570
6580
6590
λ (Å)


M2−24_a
[Ha]
Offset [arcsec]
30
20
10
0
100
200
300
V_{hel} [km s^{-1}]

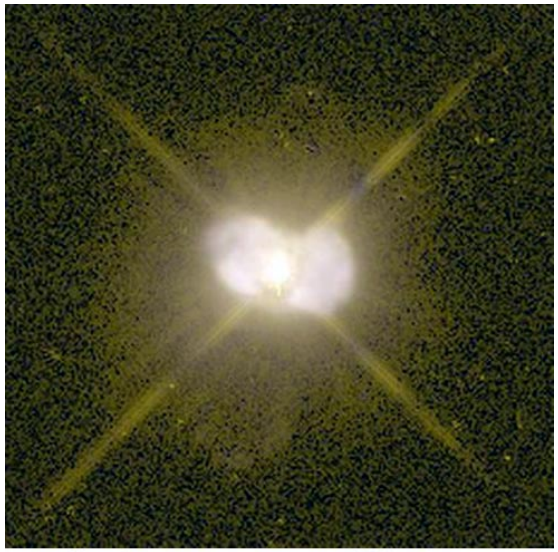
PN

Young PNe

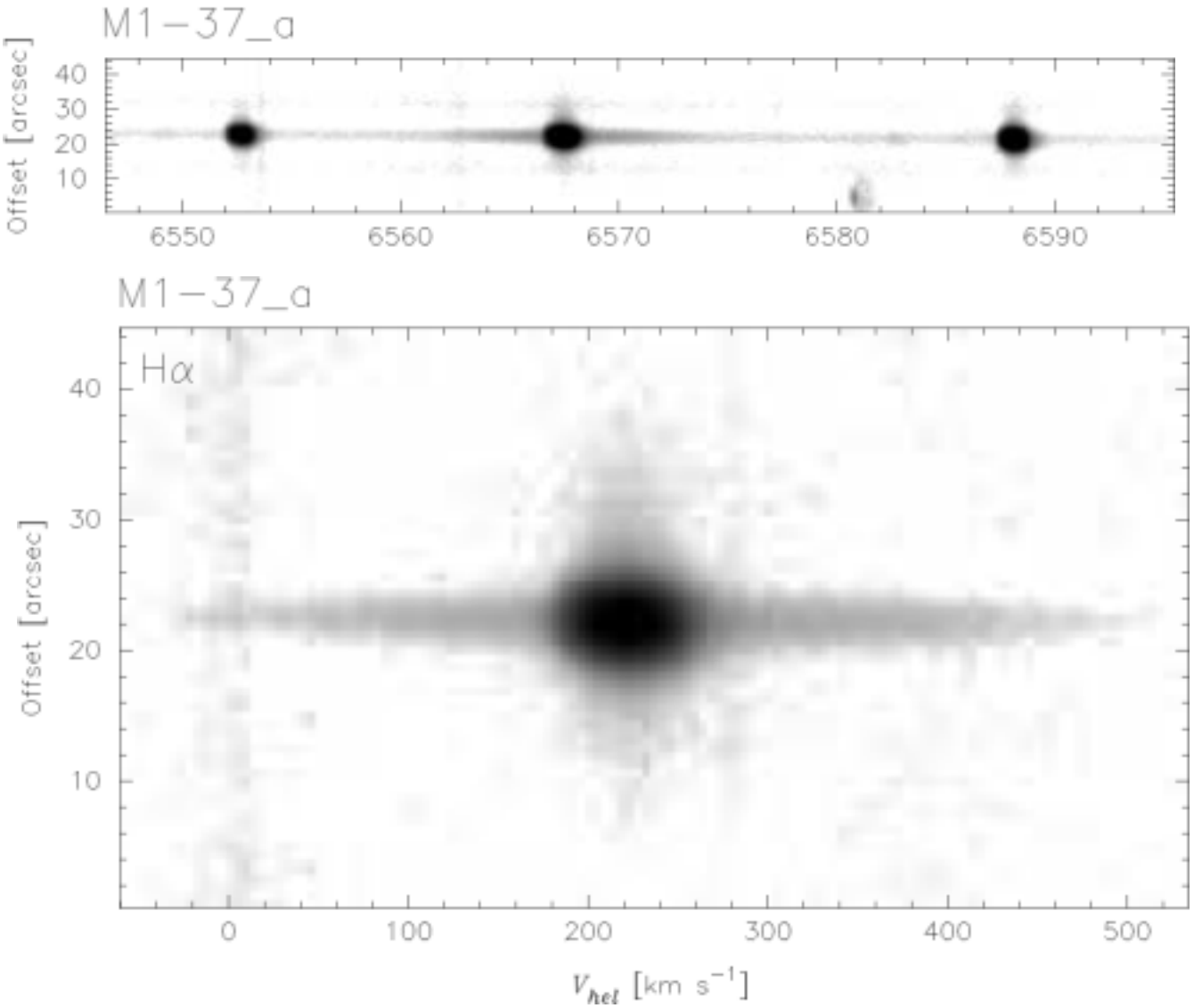


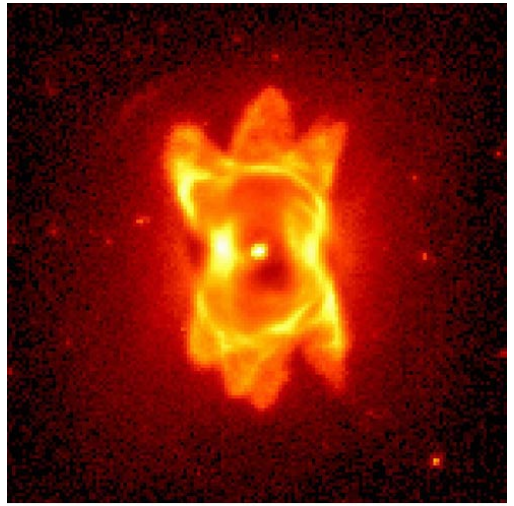
PN with dense core (N~10^9 - 10^{10} cm^3) produces enough $Ly_{\beta,}$ photons that are Ramman scattered by an HI envelope with column density, N_{HI} ~ 10^{20} cm^{-2} (Lee&Hyung 2000, ApJ 530 L49; Altschuler et al. 1986, ApJ 305, L85).

Heavy mass-loss episodes in Post-AGB and young pre-PNe can develope a neutral HI envelope around the hot emission region.



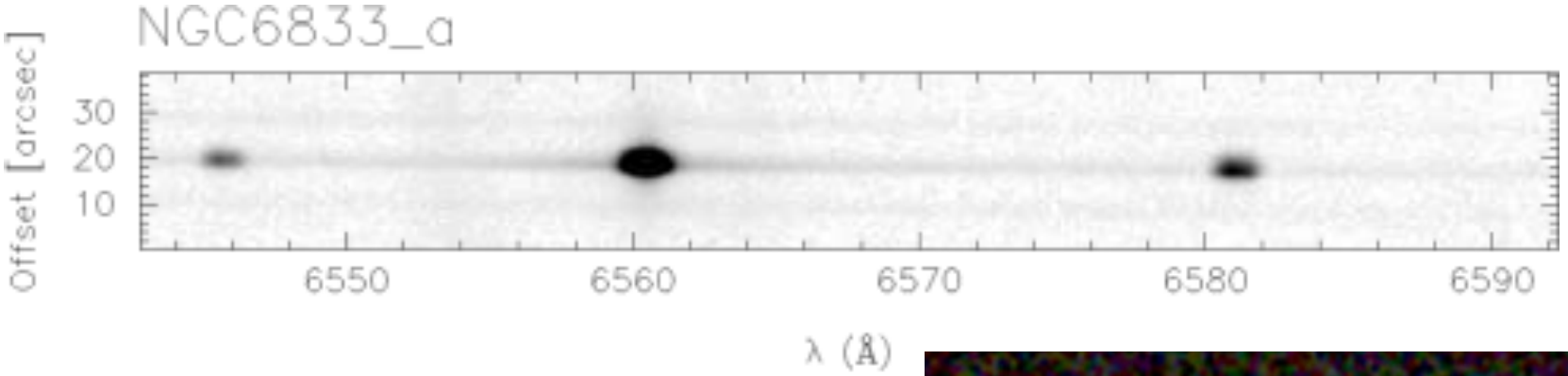
IC 4997 G058.3-10.9 20 20 08.74 +16 43 53.7, R:G:B = unknown
HST/WFPC2/PC1 N is NOT up. HST archives, GO 6119
credit: H. Bond, R. Ciardullo, and NASA





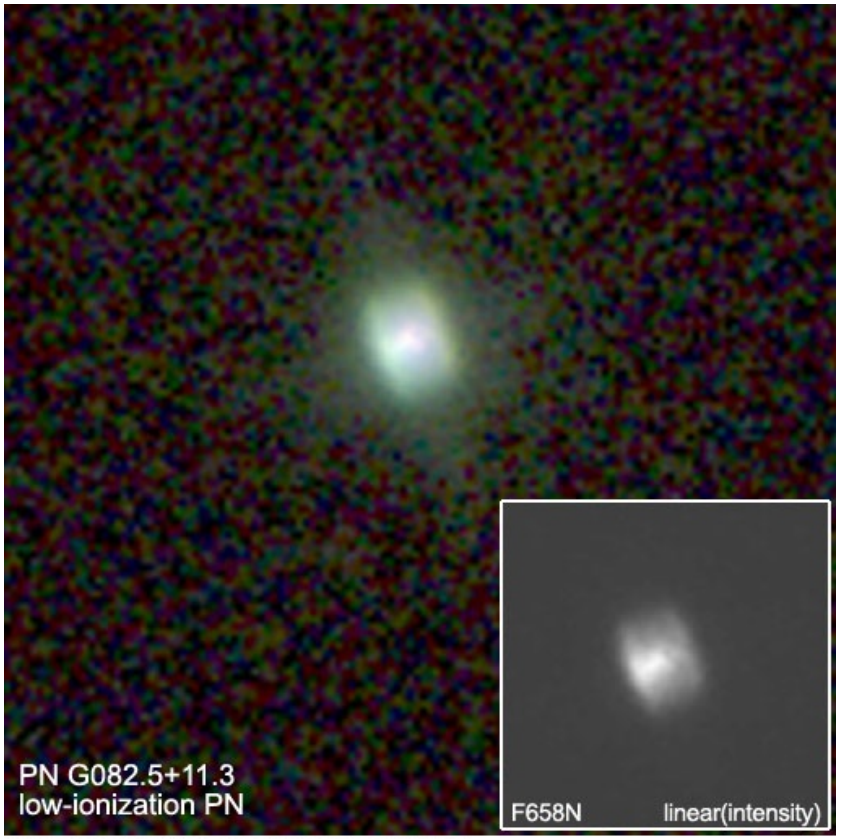
Young PN

Ramman scattering produces a Doppler enhancement factor $\lambda_{H\alpha}/\lambda_{L\beta} = 6.4$ i.e. For a H_α wing with a velocity width of 300 km s^{-1} the kinematics of the emission region is ~ 50 km s^{-1}

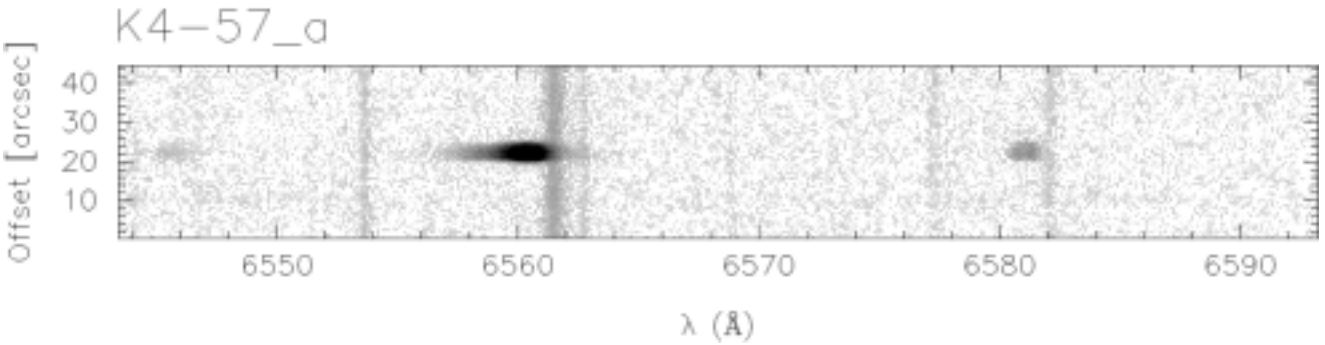


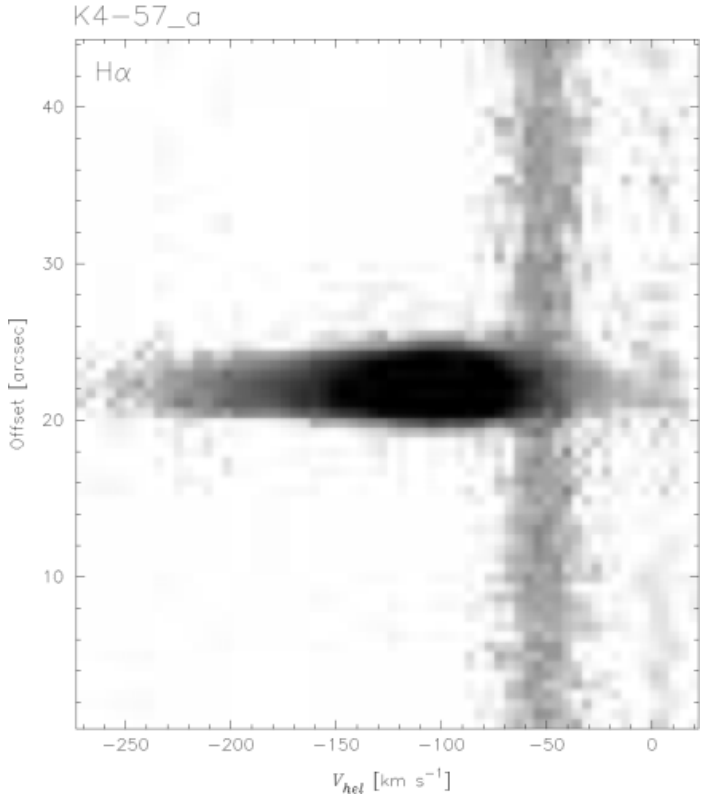
Young PN

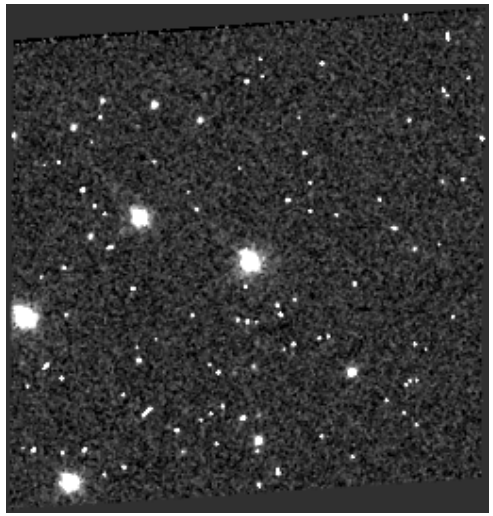
Wide wings present only in Hα



NGC 6833 [2MASS J19494657+4857401]
19 49 46.58 +48 57 40.1 (2000) FOV = 5.8" R:G:B = F631N:F658N:F656N
WFPC2/PC Credit: PI: Casertano GO6943, NASA/ESA/STScI, Hubble Archives

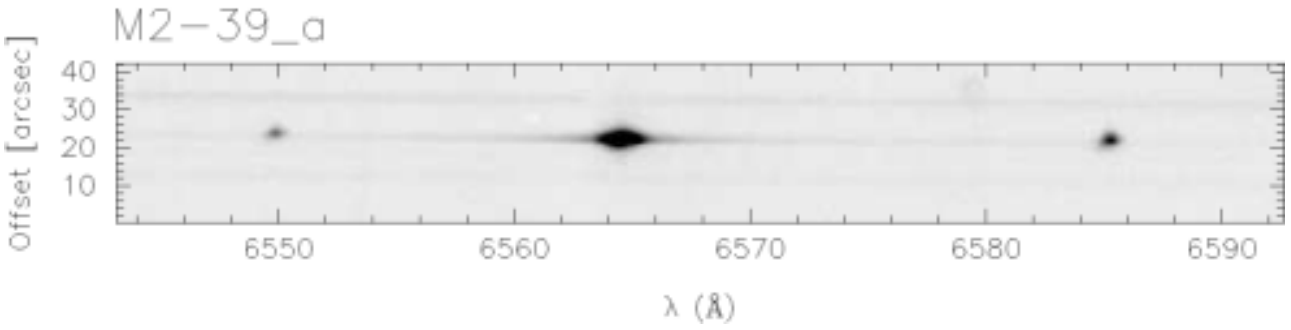


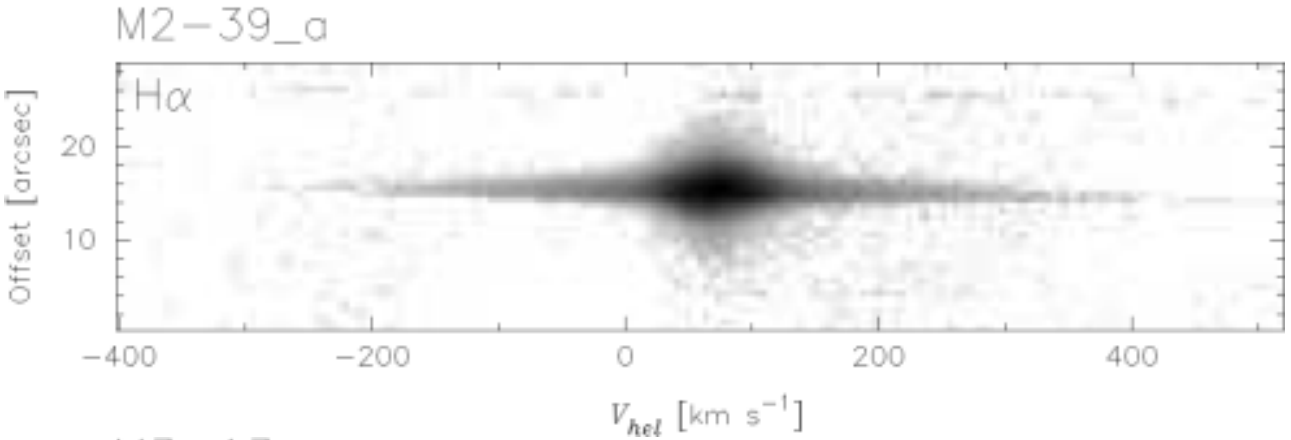




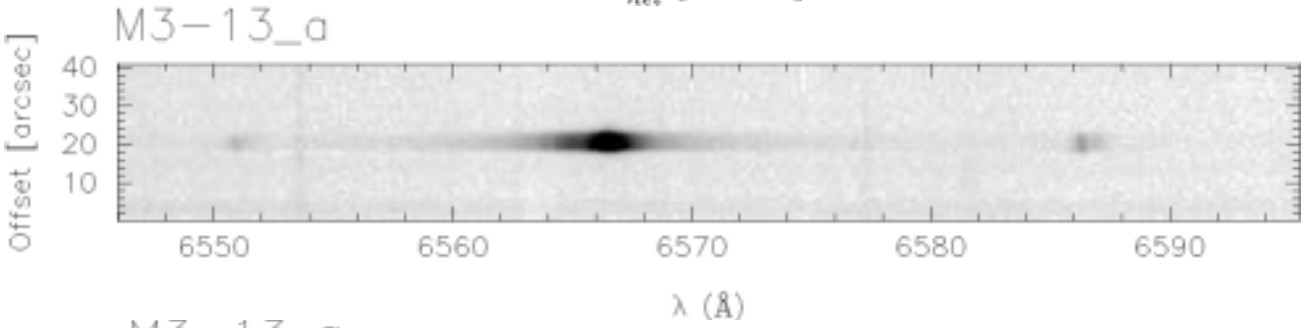
Young PN

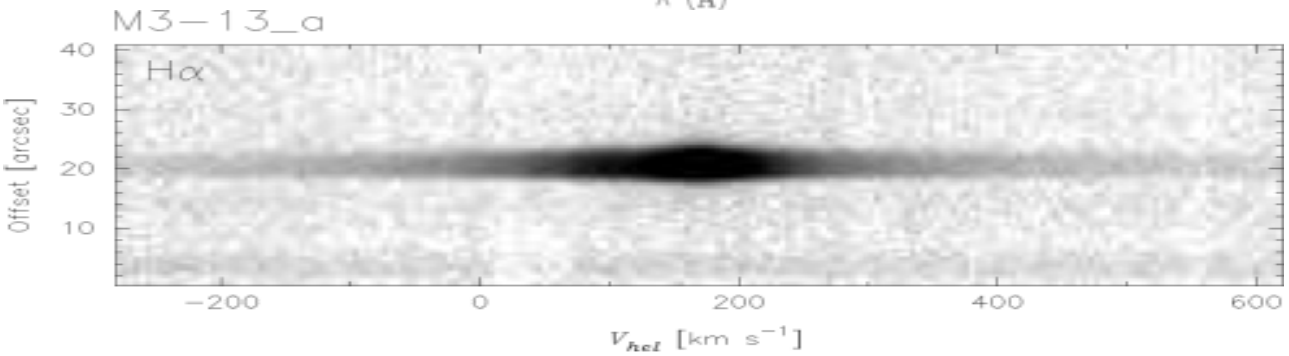
Wide wings present only in Hα





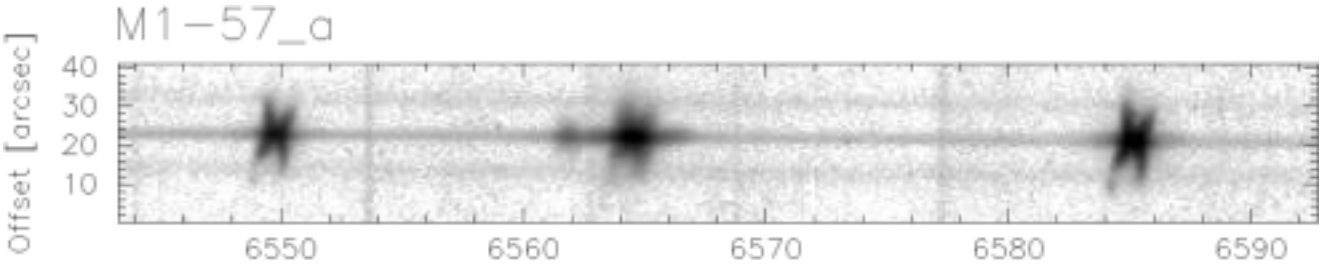
No images available

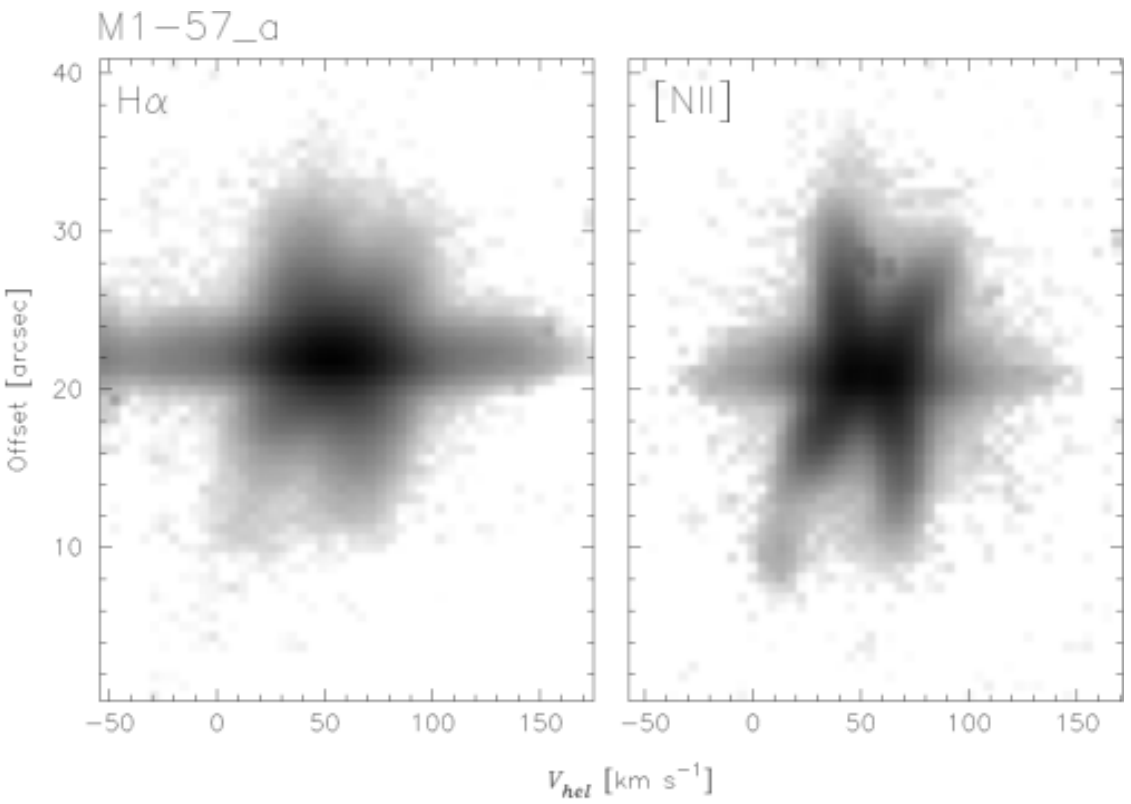


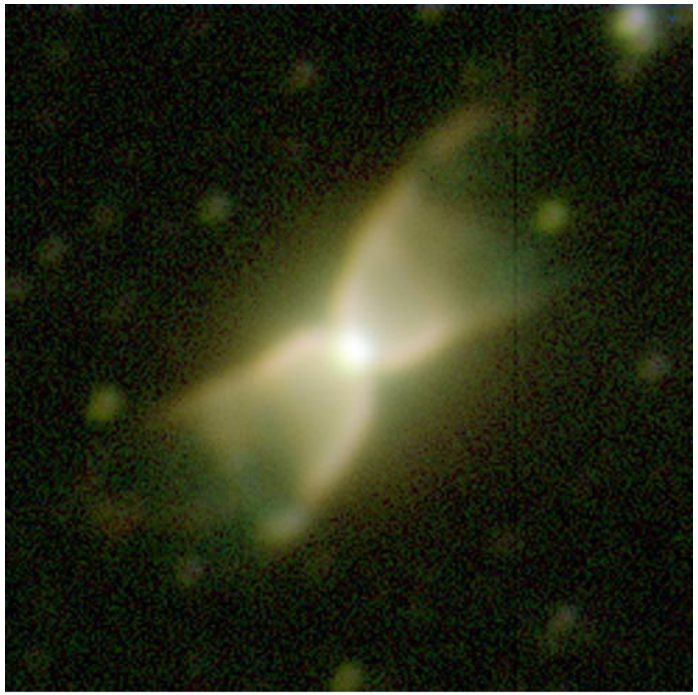


Likely Young PN or Symbotic

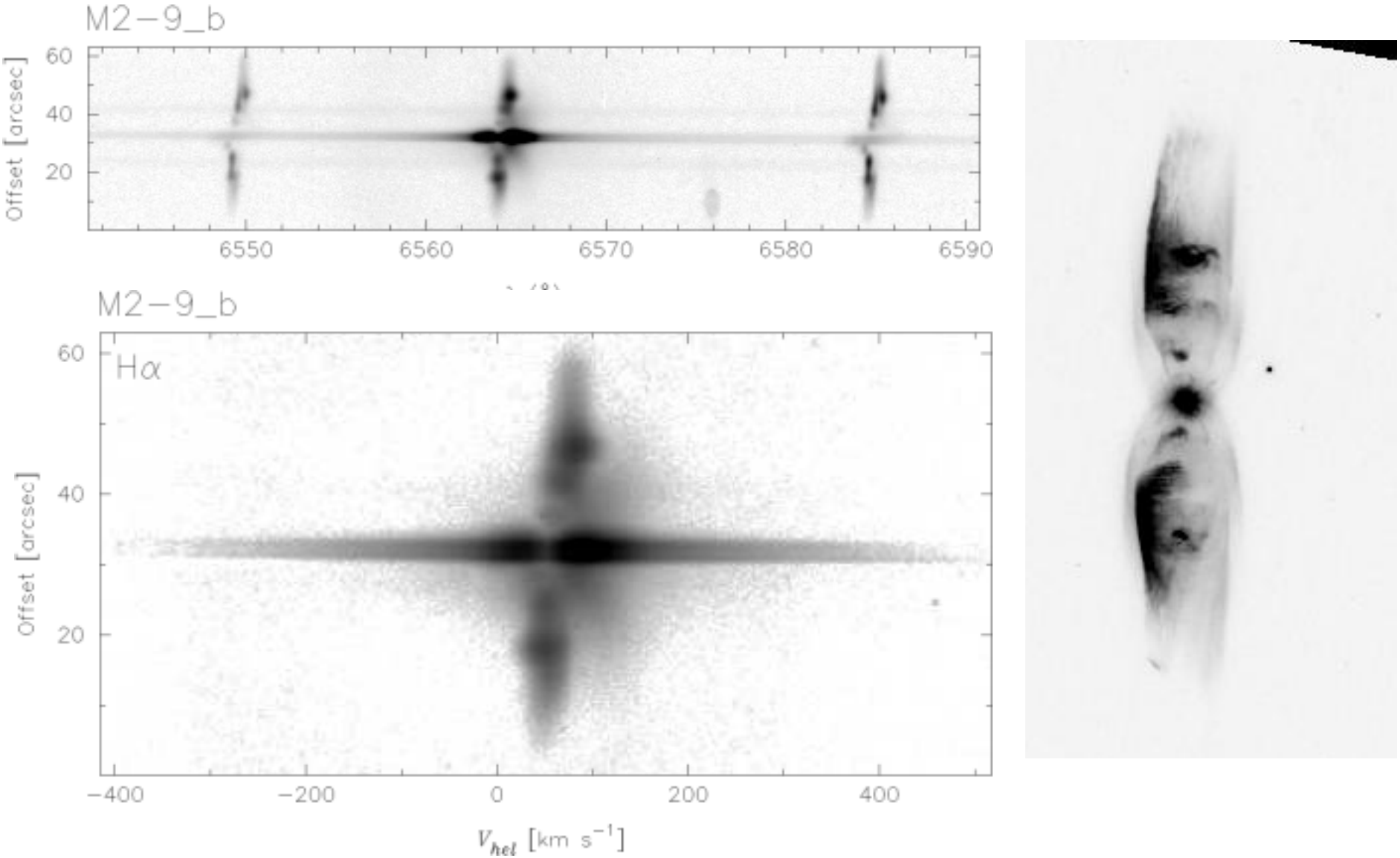
Symbiotic



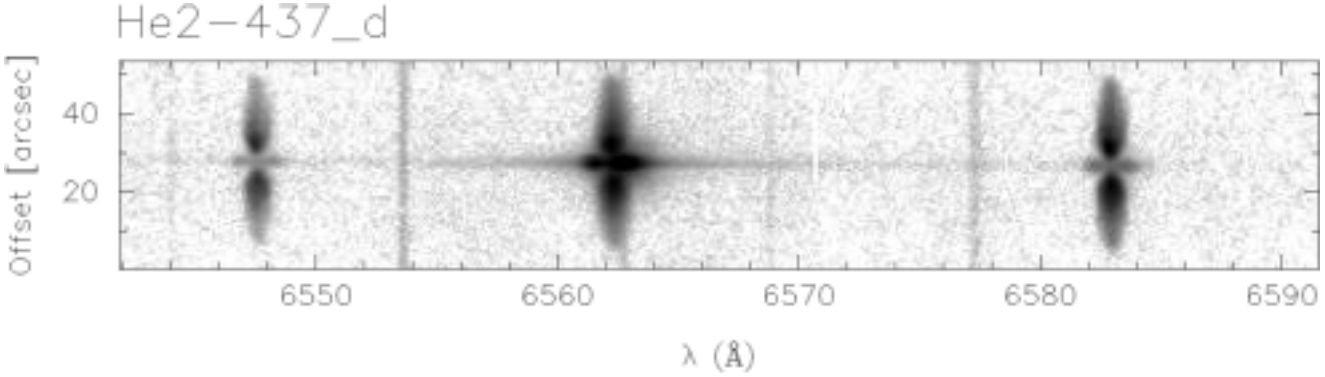


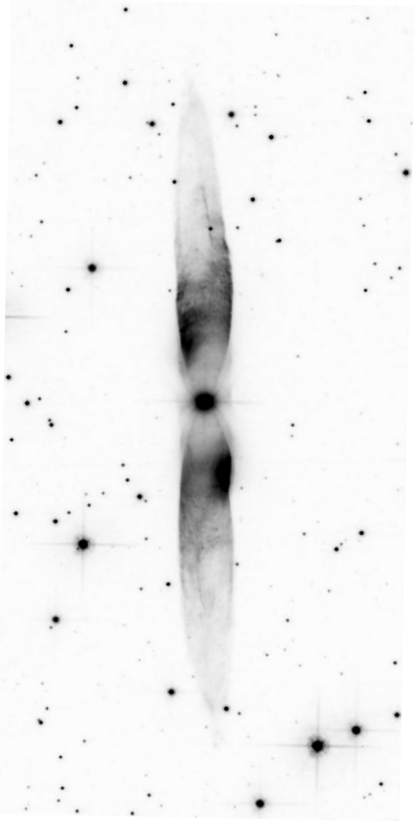


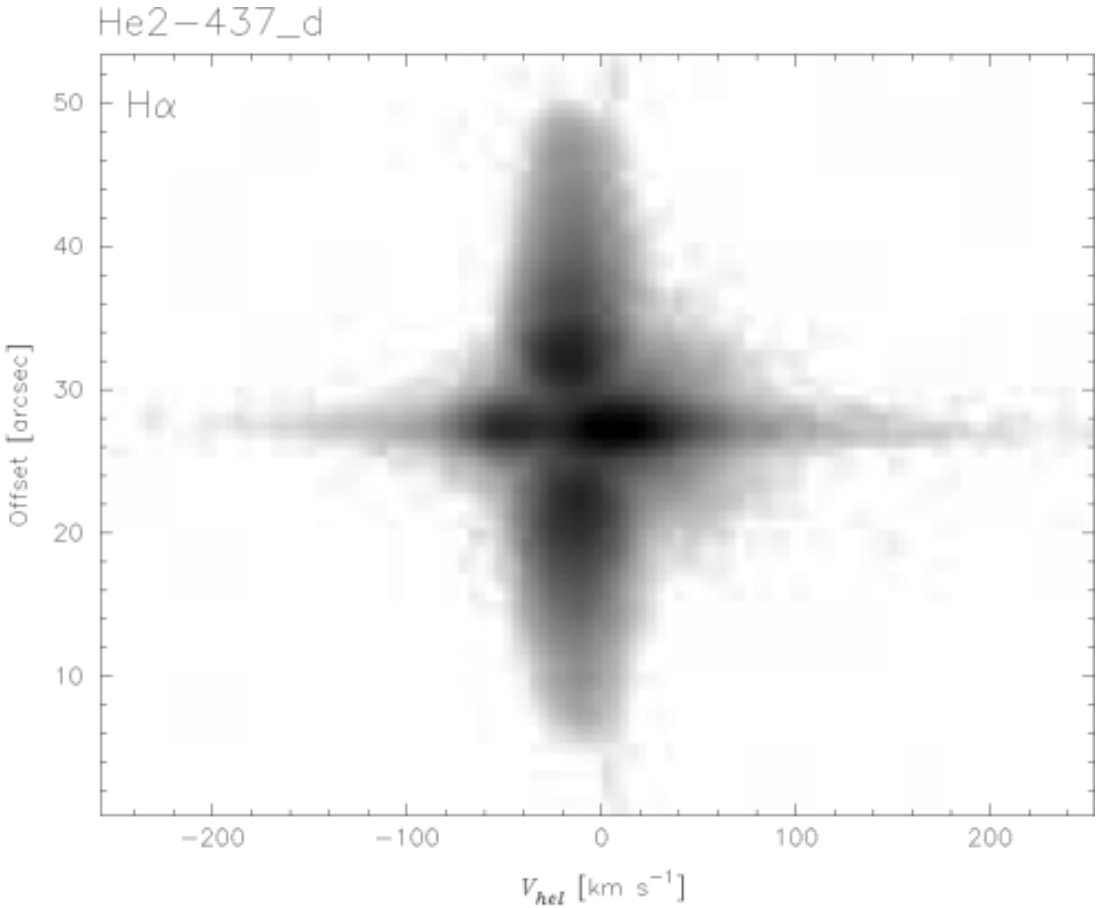
M 1-57 G022.1-02.4 18:40:20.2 -10:39:47, R,G,B = log[NII], log(Ha), log[OIII]
"The IAC morphological catalog of northern galactic planetary nebulae"
A. Manchado, M.A. Guerrero, L. Stanghellini, M. Serra-Ricart, 1996, ed. IAC

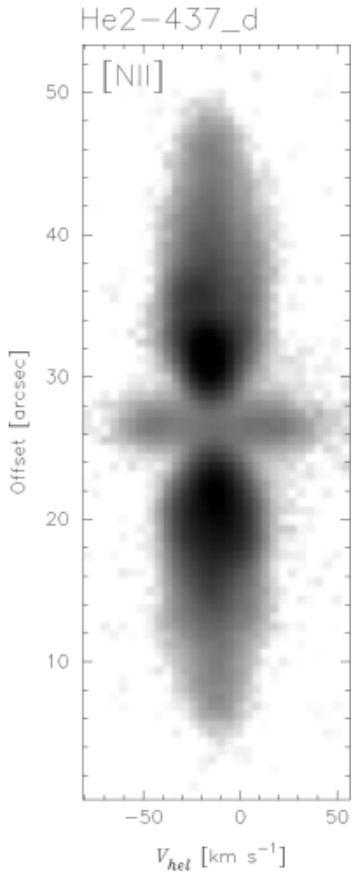


Continuum subtracted Hα profile. Notice the P-Cygni structure



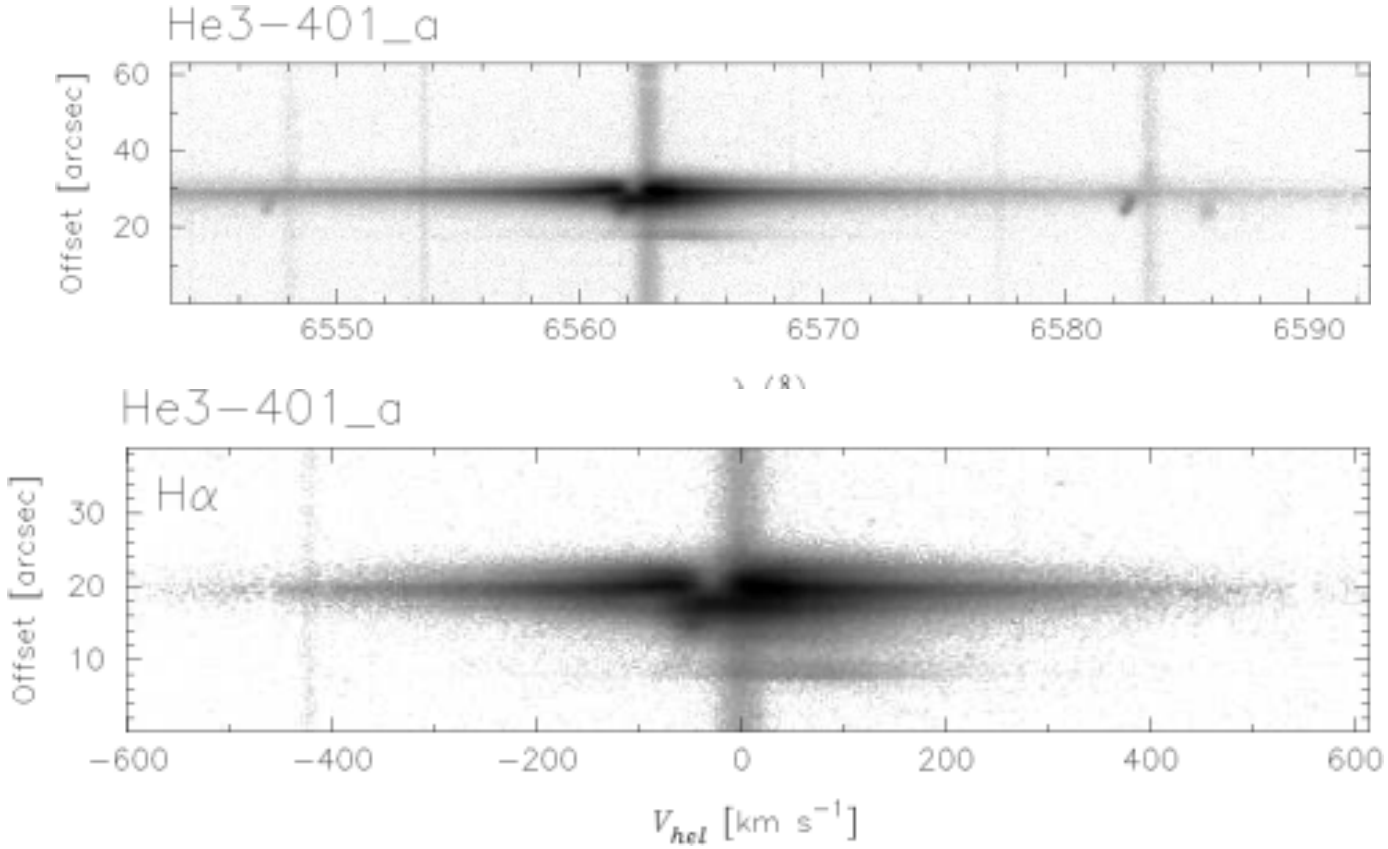


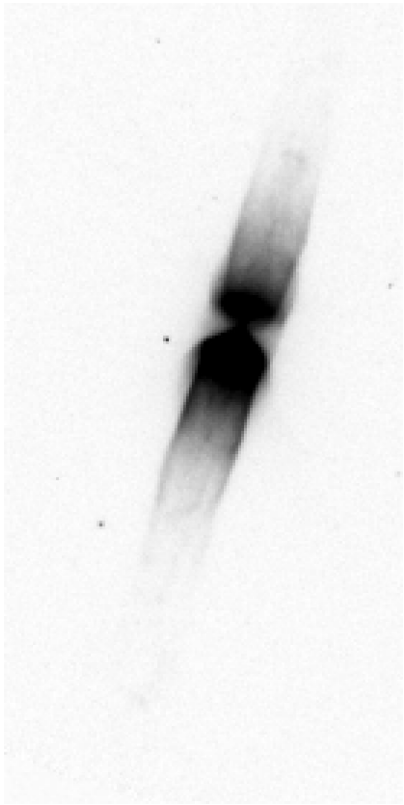




Symbiotic

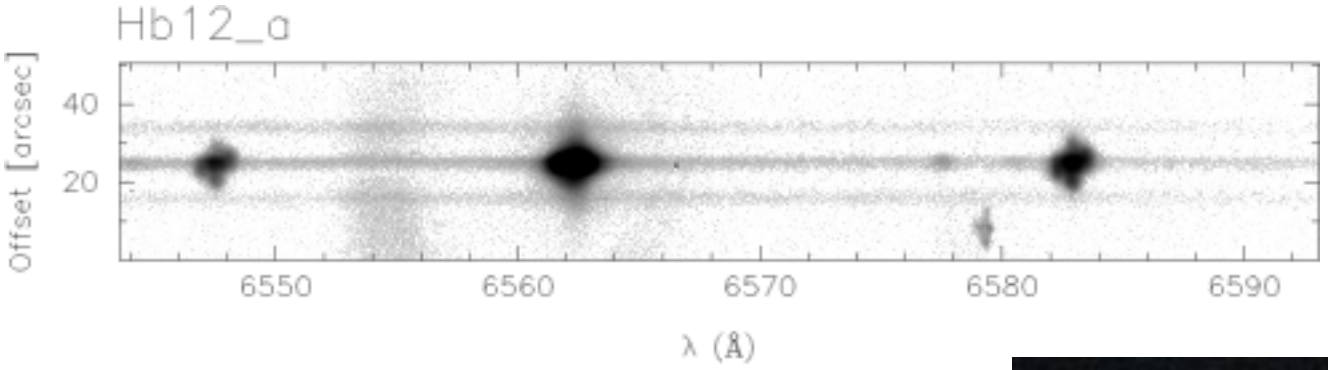
Notice P-Cygni structure in Hα



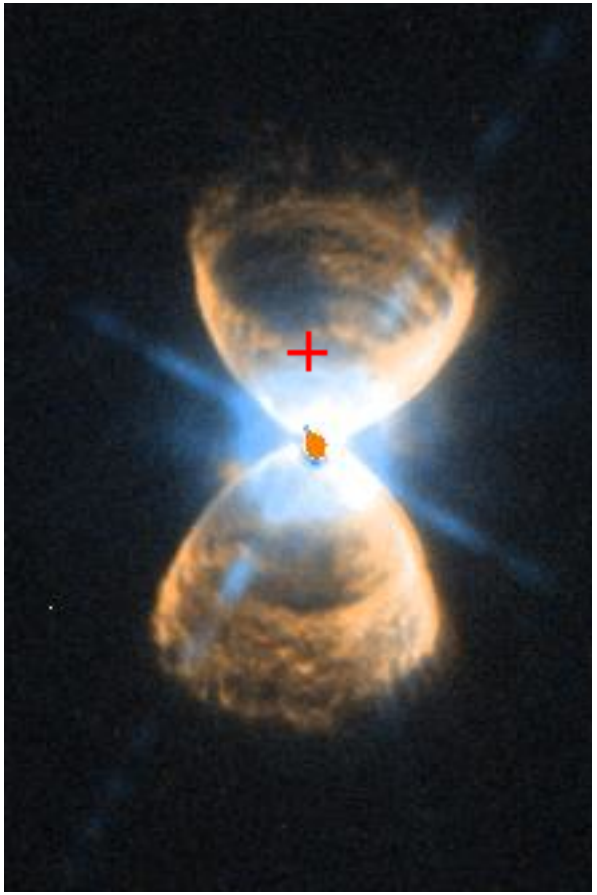


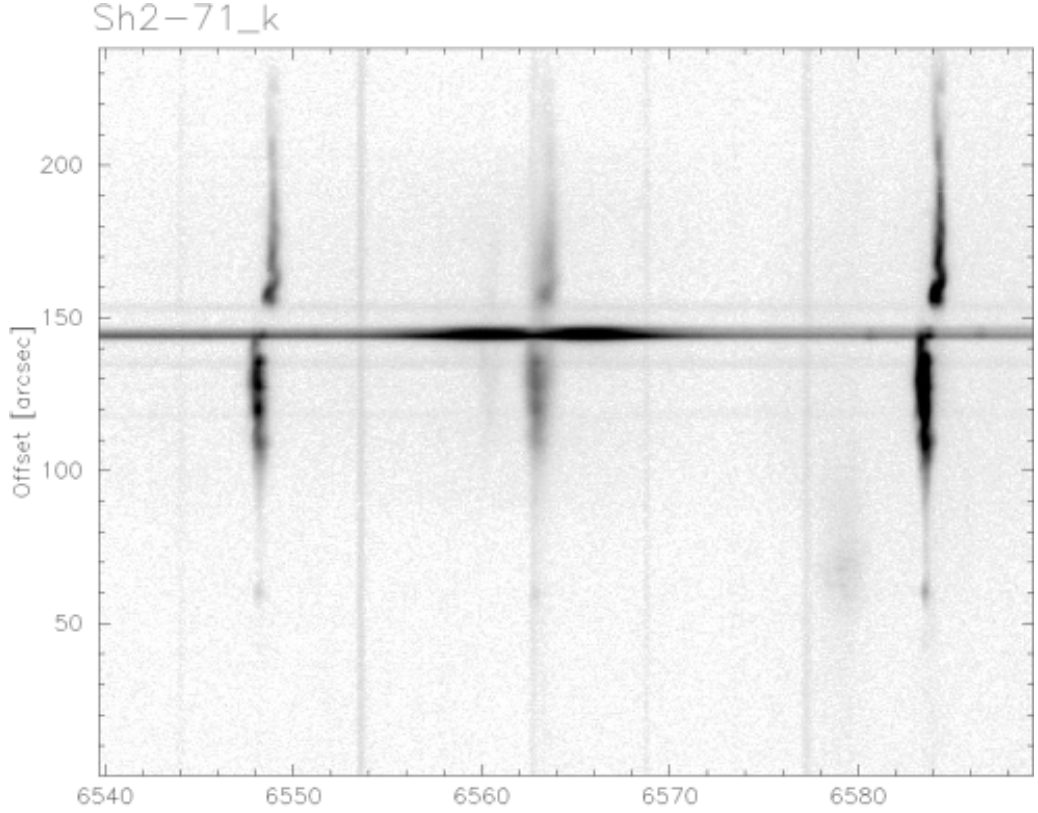
Symbiotic

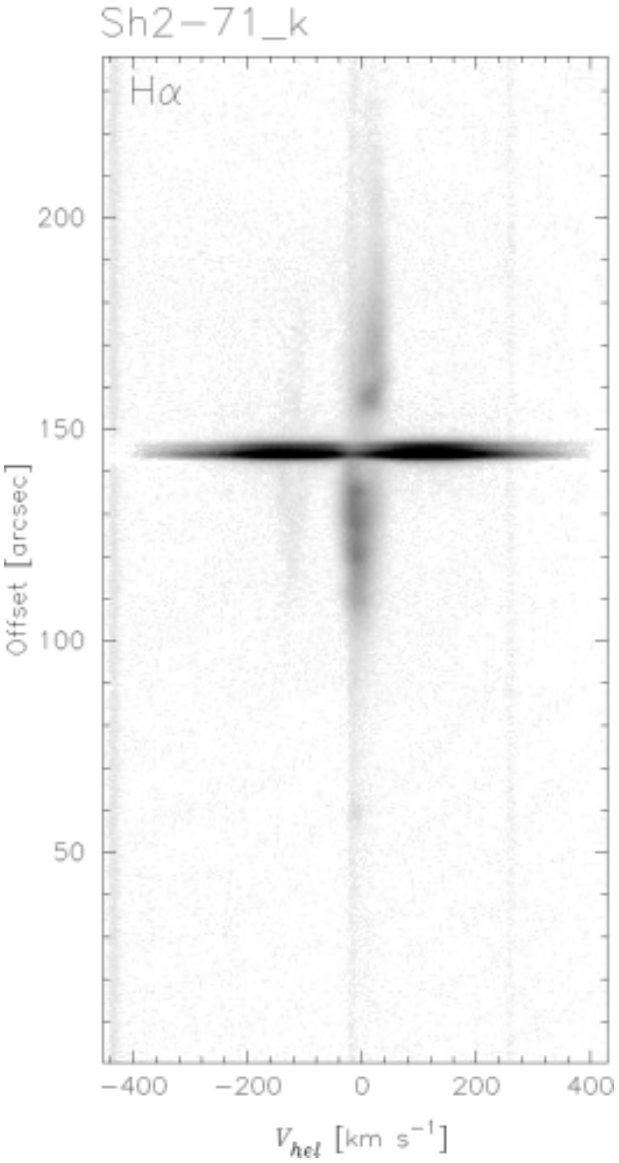
Continuum subtracted Hα profile. Notice the P-Cygni structure



Young PN similar to the symbiotic Hen 2-104. Likely symbiotic. See the talk by D.M. Clark. See also the work on wide Hα line profiles by A. Arrieta and S. Torres-Peimbert 2003, ApJSS 147, 97

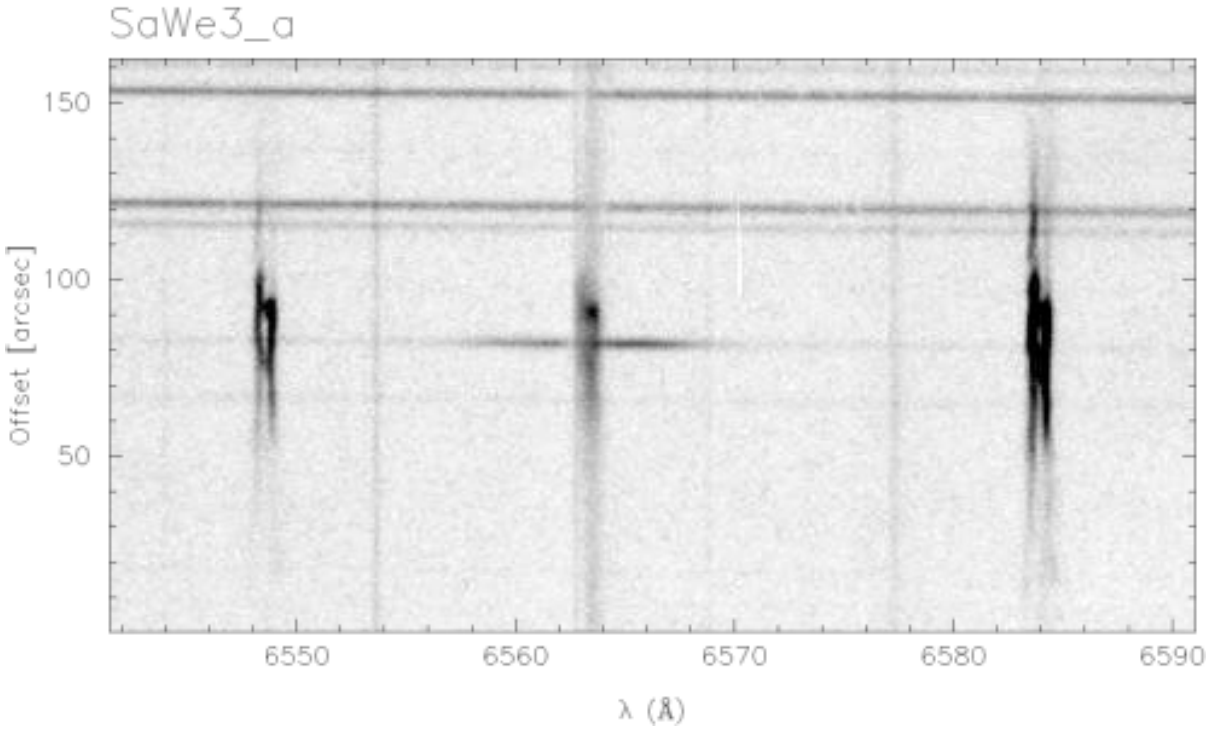


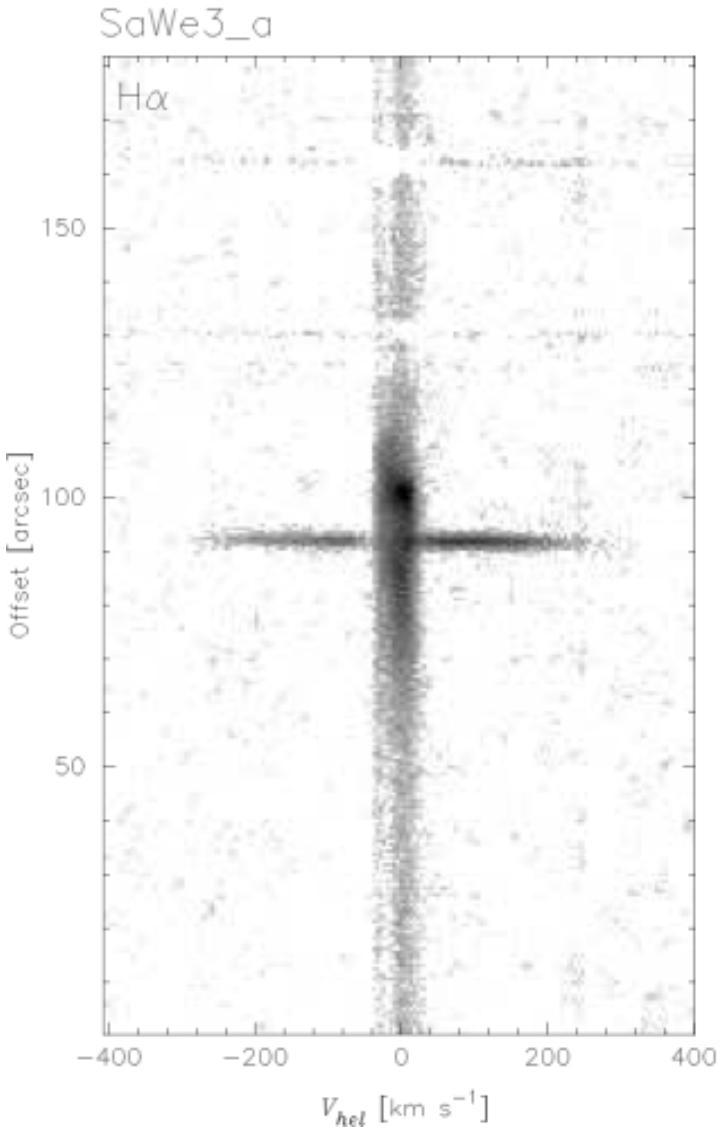


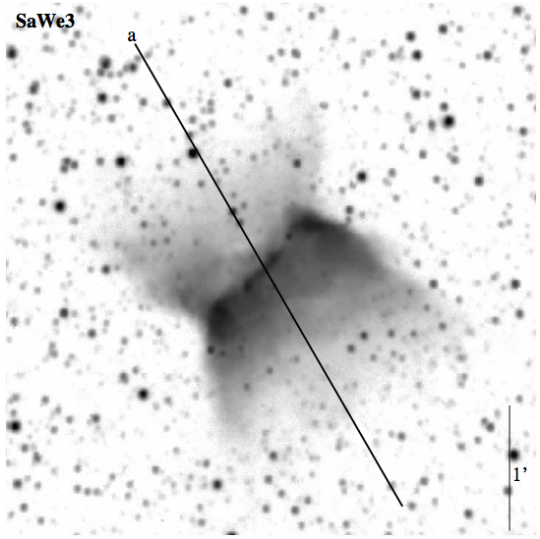


Binary core

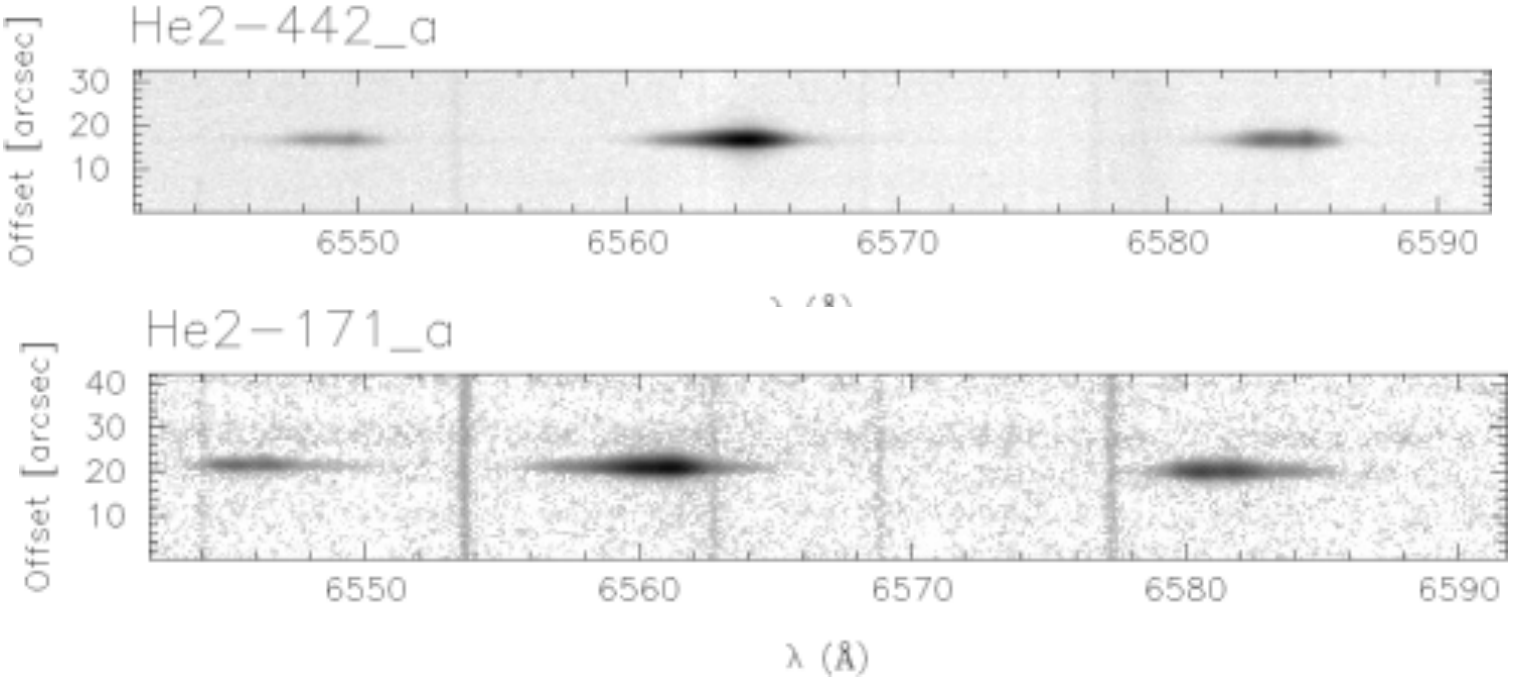
Continuum subtracted Hα profile.
Notice P-Cygni structure





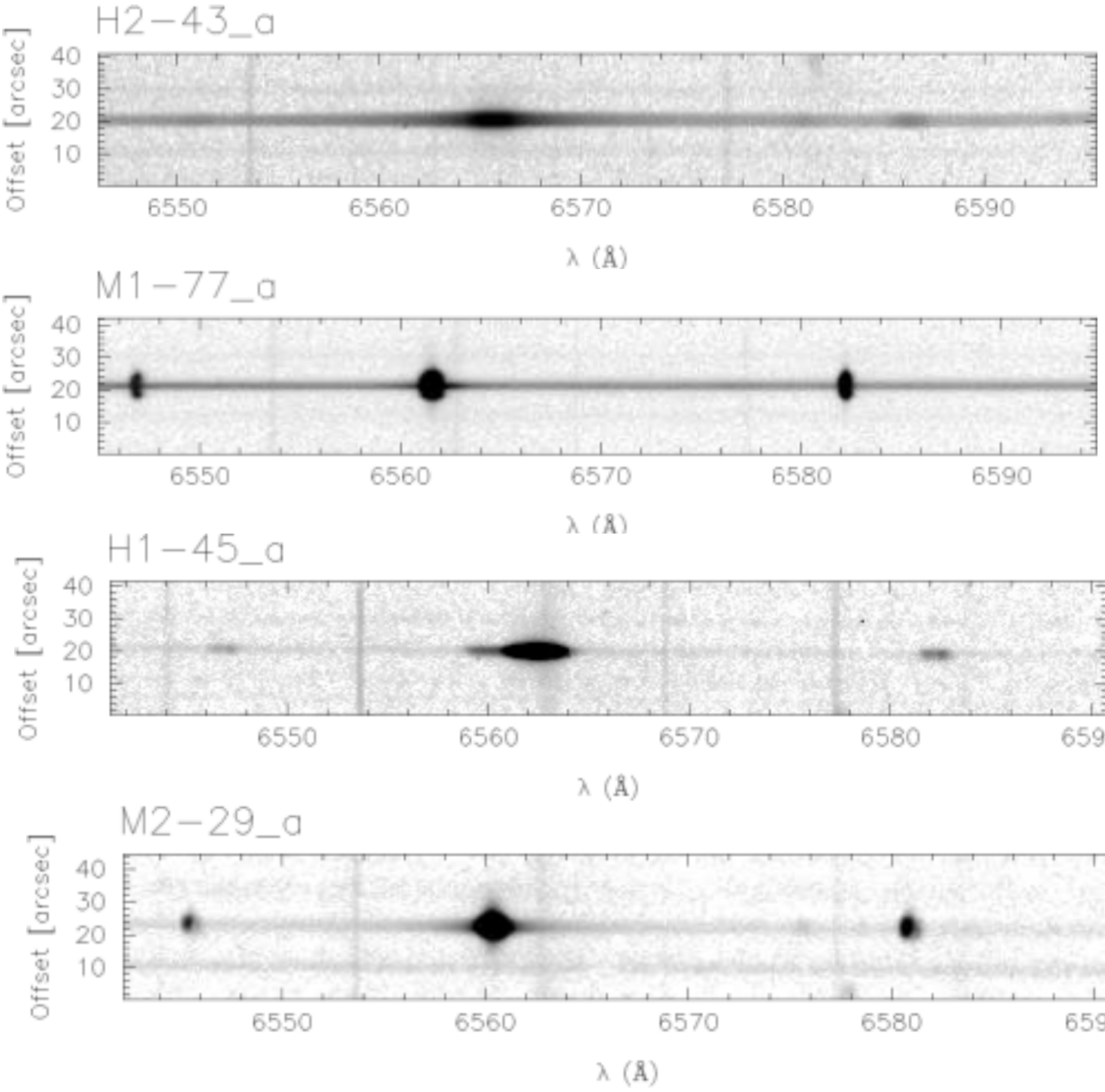


Additional data on core required, origin of wide wings uncetain.



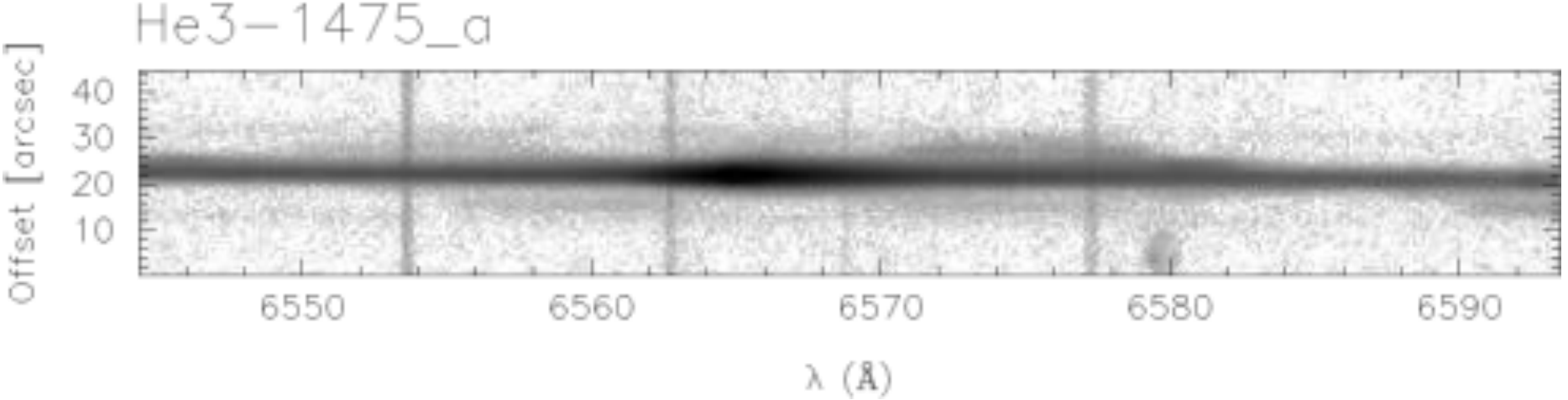
Belczynski et al. 2000, A&ASS 146, 407, suggest that He 2-442 is symbiotic

Van Wickel, Duerbeck and Schwartz, 1993, A&ASS 102, 401, report a Mira in He 2-171

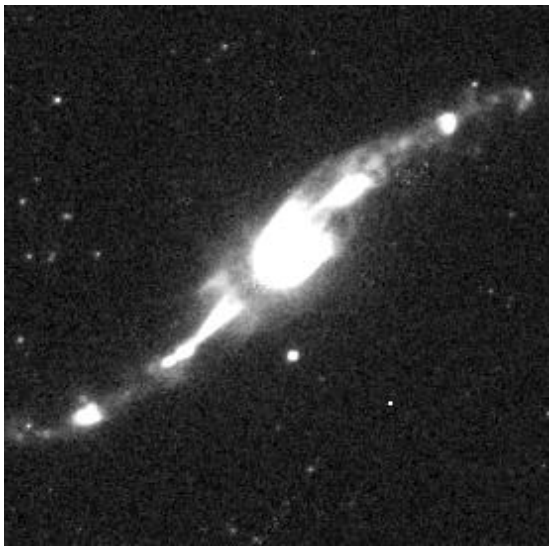


H 2-43 & M 1-77: 2 new symbiotics discovered in the Kinematic Catalogue of Galactic Pne (López et al. 2012 RMAA 48, 3.

H 1-45 & M2-29 Miszalski , Mikolajewska & Uadalski 2013 MNRAS, 432, 3186



Spectrum obtained along major axis



Sánchez-Contreras & Sahai, 2001, Apj 553, L173 find P-Cyg type profiles in Hα at the core from STIS-HST spectra.

Summary

Wide H_α wings:

Help identify PNe with nearly pole-on large bipolar outflows.

Help disentangle PNe from Symbiotics i.e. cleans and improves the population sample in both cases.

Help to identify young PNe or pre-PNe with large neutral envelopes from recent, heavy mass-loss episodes.

Help characterize the kinematics of the inner emission region considering Raleygh-Ramann scattering. Dense winds and neutral envelopes produce the absorption component in the $H\alpha$ emission line profile

Help identify exotic objects.

Different scenarios. Physics of line profile formation needs better understanding in some cases. Valuable information on core structure stored in these profiles.