Scientific Capabilities

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CASA-ARL

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- **Wavelength range:** 0.85 to 2.5 μm
- **Pixel Scale and Field of View:** single image scale
  - Pixel scale of 0.28 ±0.02 arcsec/pixel for Hawaii 1 1024×1024 HgCdTe detector with 18.5μm pixel pitch
  - Field of View of 4.8′×4.8′ (6.75′ across diagonal)
  - Minimized and well-characterized image distortion to allow accurate astrometry

Filters

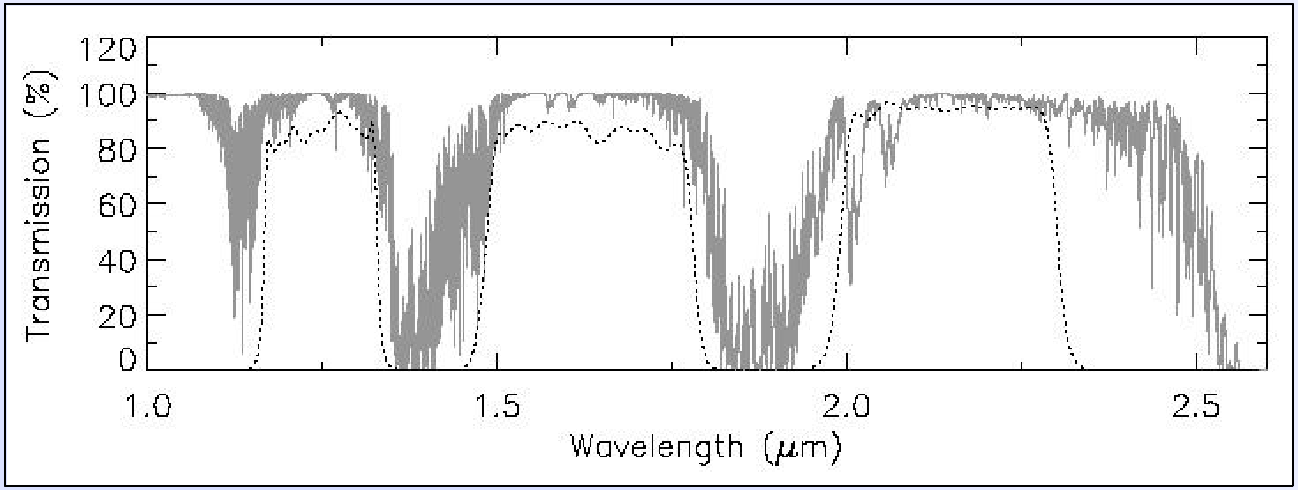
- Two 10-slot filter wheels provide 16-18 slots for science filters
- Nominal filter size 65 mm diam. × 5 mm thick, 5° tilt
- Core Filters

Core Filters	Central	Cut-on	Cut-off
– MKO J	1.25	1.17	1.33
– MKO H	1.63	1.49	1.78
– MKO K_S	2.15	1.99	2.31
– [Fe II]	1.644	1.639	1.649
– H_2 1-0 S(1)	2.122	2.117	2.127

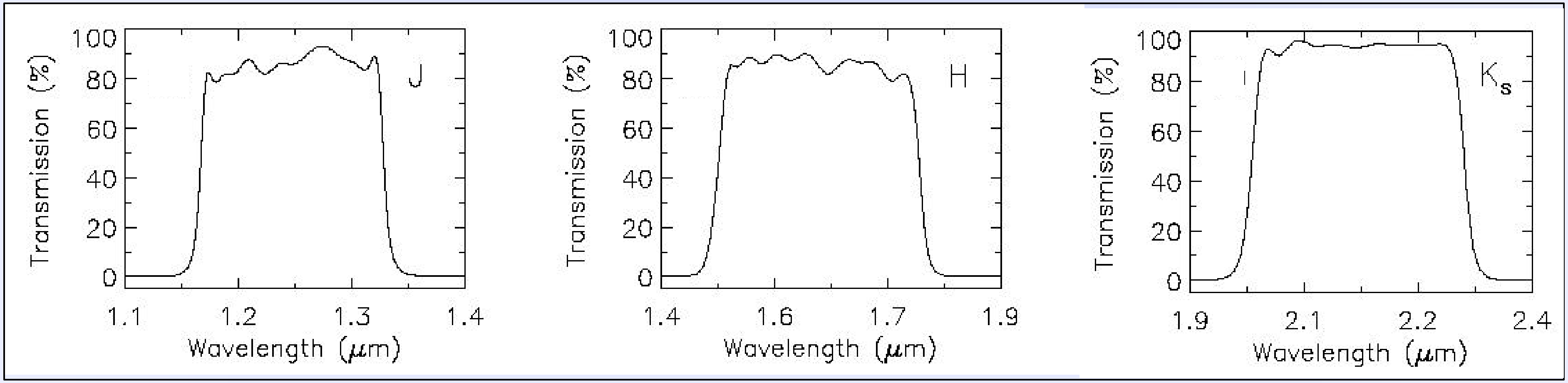
- Hi-pri Filters

Hi-pri Filters	Central	Cut-on	Cut-off
– z	1.01	0.90	1.12
– MKO K	2.20	2.03	2.37
– [Fe II] red/cont.	1.652	1.647	1.657
– H_2 red/cont.	2.13	2.125	2.135

• MKO Broad-band Filter Set



• Compatible photometric system
• 65 mm diameter also used at CTIO and elsewhere



Filters (cont.)

- Additional filters sought by ARC community
- Most requests desire duplication of GRIM II filters, some requests for new filters
- Wish-list includes:

  [S III]λ0.953; [C I]λ0.985; [S II] λ1.03; He I λ1.08; Pa $\gamma\lambda$1.09;
  H_2 S(1) lines at λ1.233, λ1.311, λ2.248; Pa β λ1.28 + redshifted/cont.;
  H_2O/CH_4 + cont. at λ1.27, λ1.385; CH_4 + cont. at λ1.58, λ1.70;
  H_2O/NH_3 at λ1.53; Br $\gamma\lambda$2.16 + redshifted/cont.; K'; K_{long}; CO_2 λ2.3;
  H_2 Q-br λ2.43; etc.

Detection Limits

Estimated 5-sigma detection limits over a 4x4 pixel aperture

Band	1 minute	1 hour
z	20.7	22.9
J	20.0	22.2
H	18.7	20.9
K	18.0	20.2

- Estimates are for time on target only, and do not include overhead due to readouts or sky subtraction.
- Estimated sky saturation times for J, H, K bands are 55, 5.5 and 6 seconds, respectively.
- Dark current 0.5 e^-/pixel/s, Readnoise 10 e^-/pixel rms, System Throughput 0.33.
- Sky Brightnesses for z, J, H, and K bands are 19, 17, 15, are 13 mag $arcsec^{-2}$, respectively.

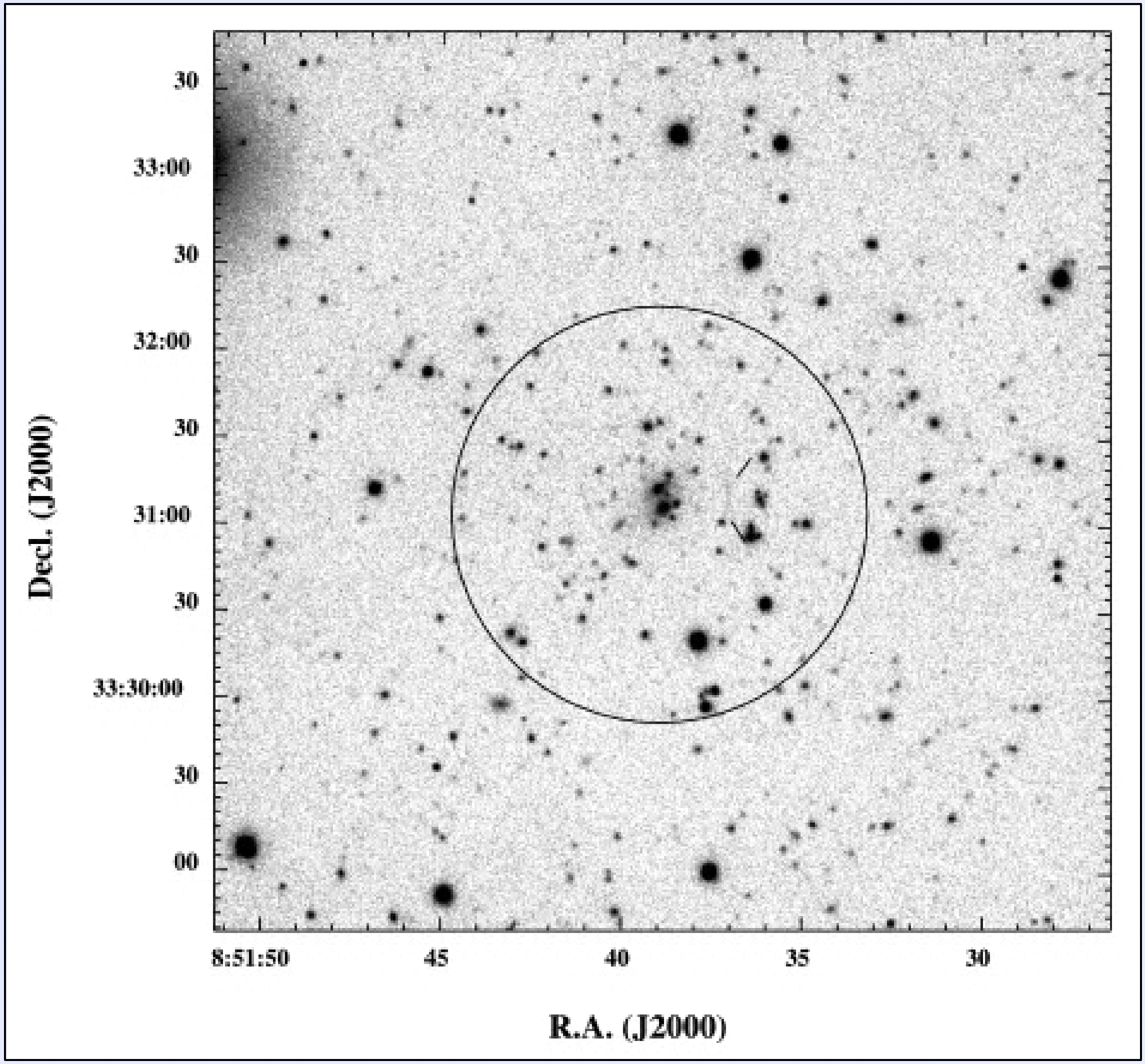
NIC-FPS Preliminary Design Review

Galaxy Clusters

- Cluster morphology and evolution
- Spheroidal population evolution
- Cluster core radius of 1 h^{-1} Mpc corresponds to ~4 arcmin at z = 0.5

Example:

- X-ray selected galaxy cluster from Lewis et al. (2002)
- KPNO 2.1 m 1800s Gunn r exposure
- T1KA with 0.305”/pix
- Cluster at redshift z ~ 0.45
- Circle is 0.5 h^{-1} Mpc radius centered on BCG
- Note arcuate lensed galaxies

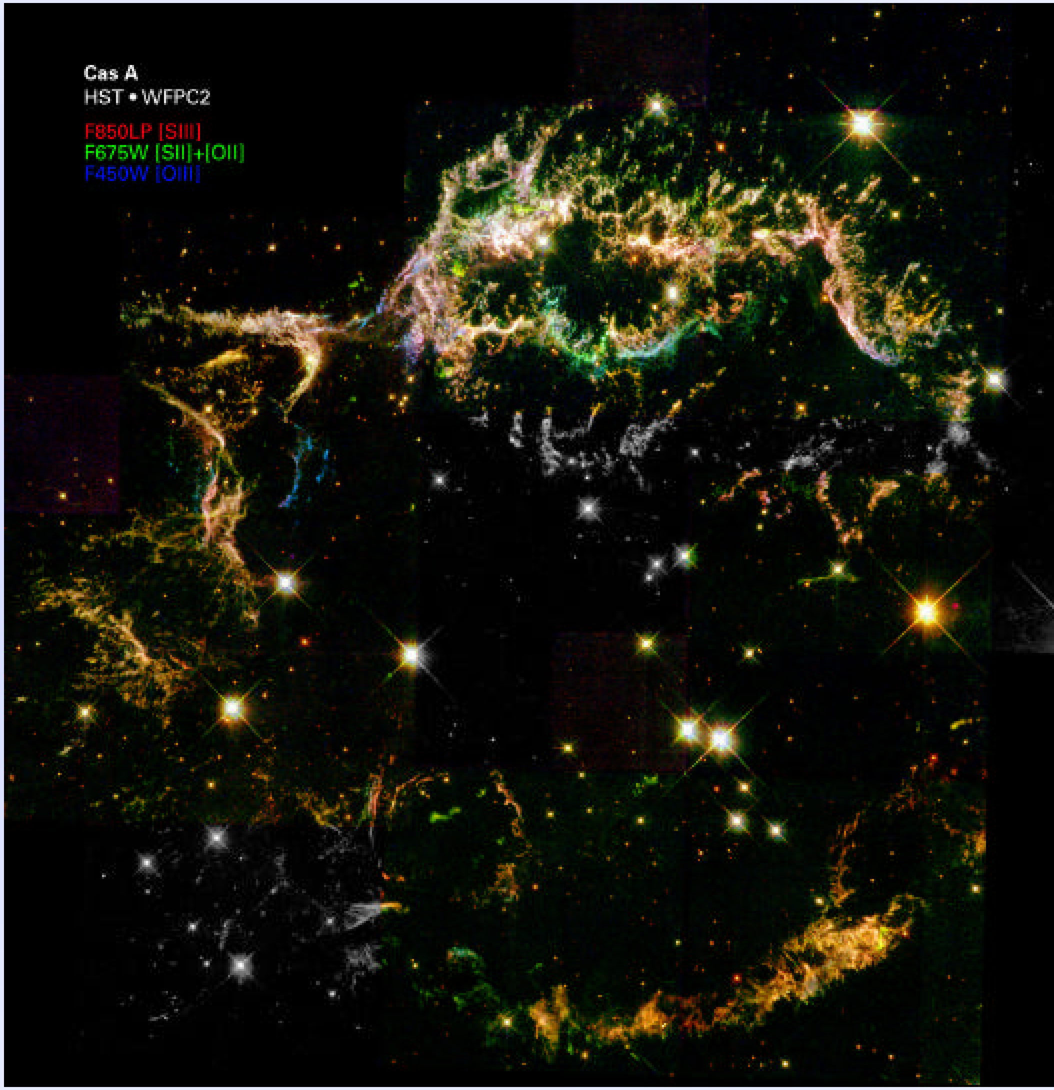


Galactic Nebulae

- H II regions, protostellar jets/outflows, PNe, LBVs, SNRs, nova shells, etc.
- Morphologies, kinematics; radiative shocks, photoionized gas, dust
- 6 pc subtends ~4 arcmin at D = 5 kpc

Example:

- Cas A supernova remnant
- SN ~1680, D ~ 3.4 kpc
- Main shell diameter ~4 arcmin
- High-extinction sight-line
- Probe Fe distribution and kinematics plus other tracers of nucleosynthesis
- Forward/reverse shock physics



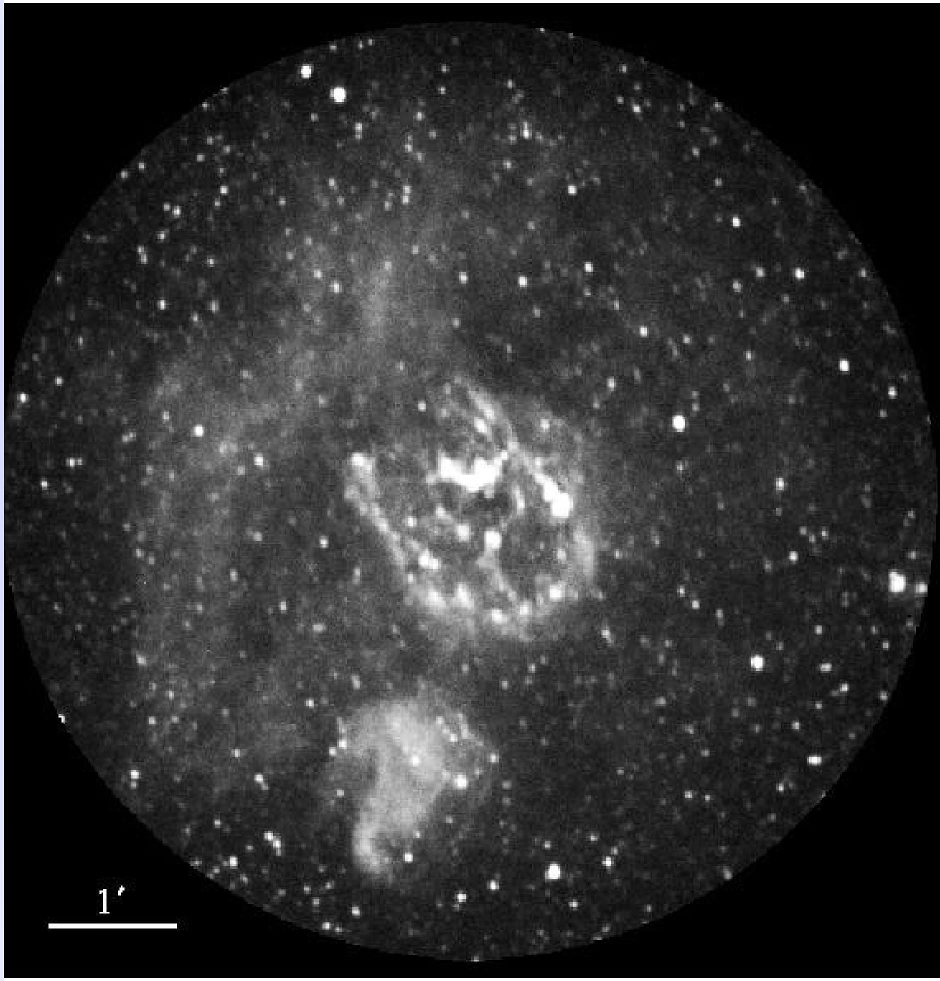
Fesen et al. (2001)

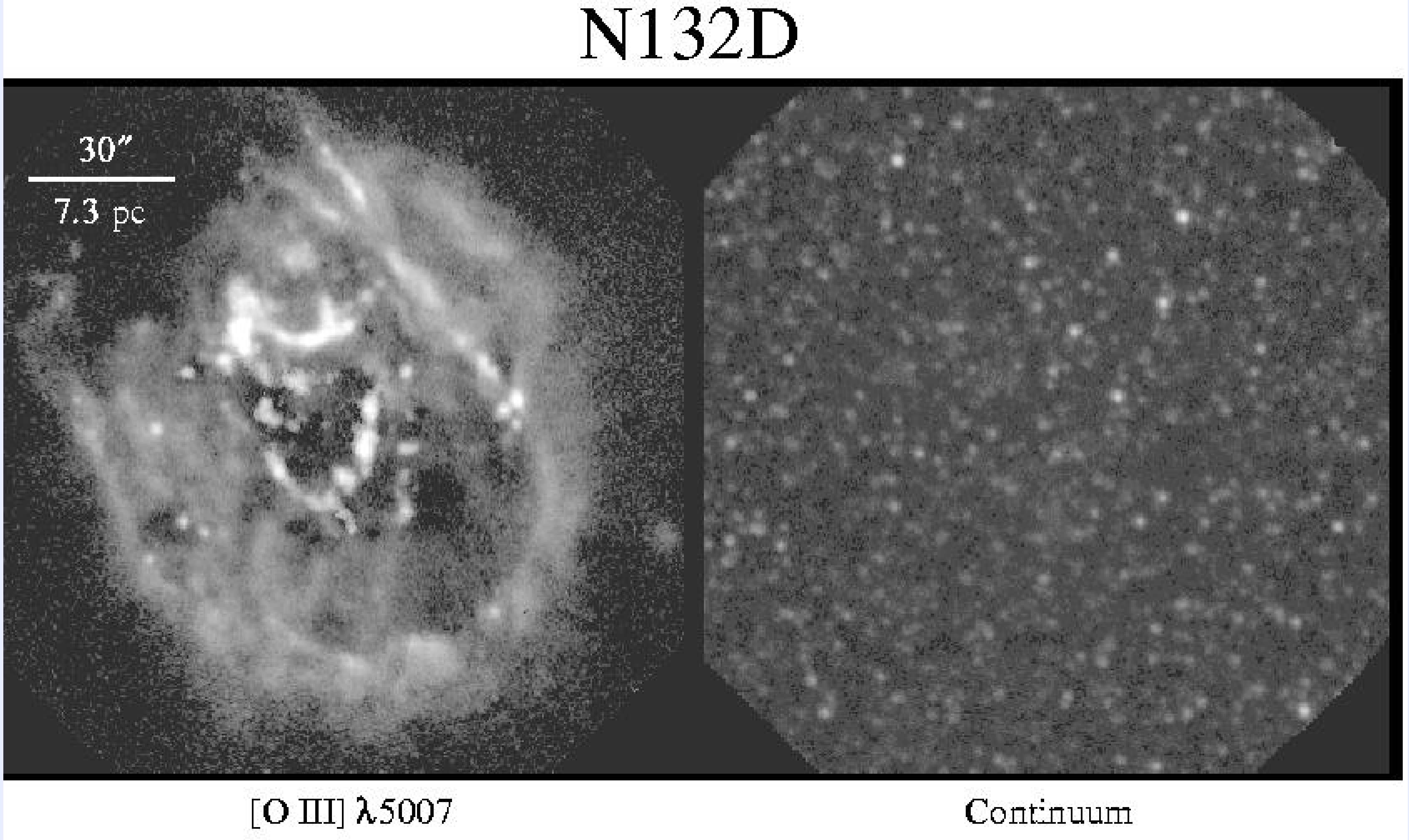
Uniqueness of cryogenic Fabry-Perot capability

- Value of full-field kinematics and fluxes
- Can be used to probe line emission or absorption
- Mature data reduction software and ample computing power/disk storage available

<u>Example:</u>
Optical F-P observations of young SNR N132D in the LMC (Morse et al. 1995)

N132D Hα





• Very narrow bandpass allows for high-S/N images with excellent continuum subtraction.

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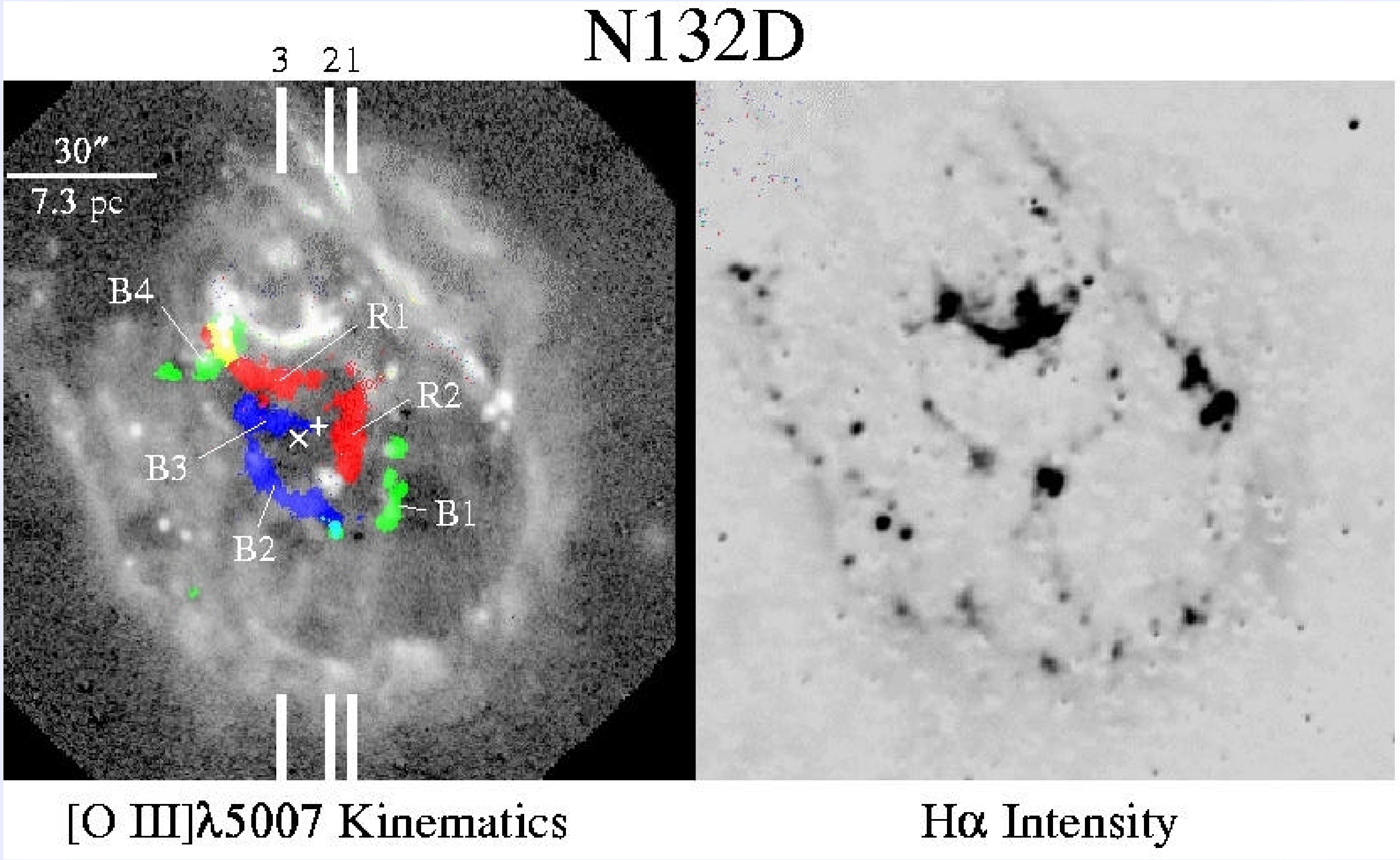
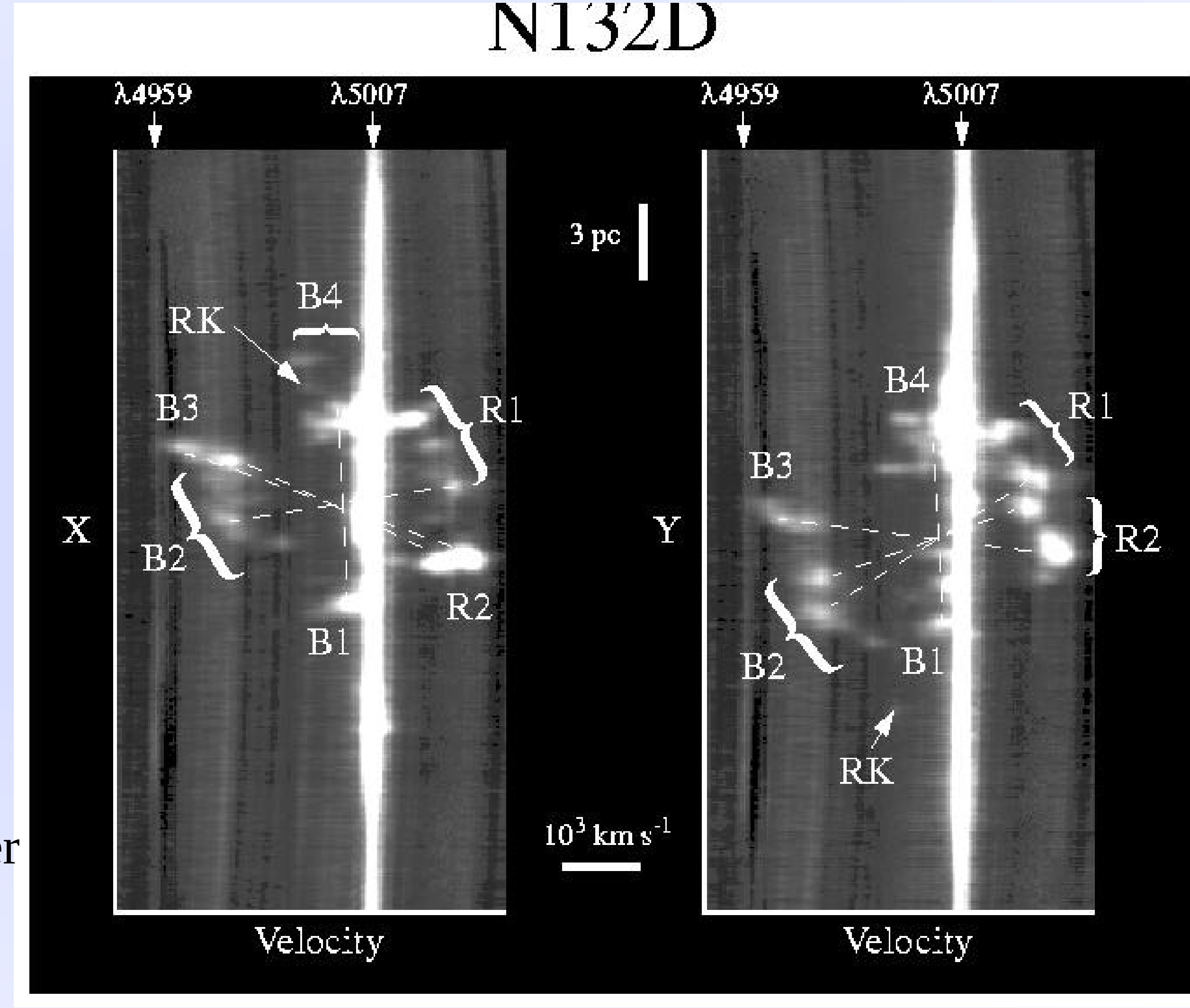
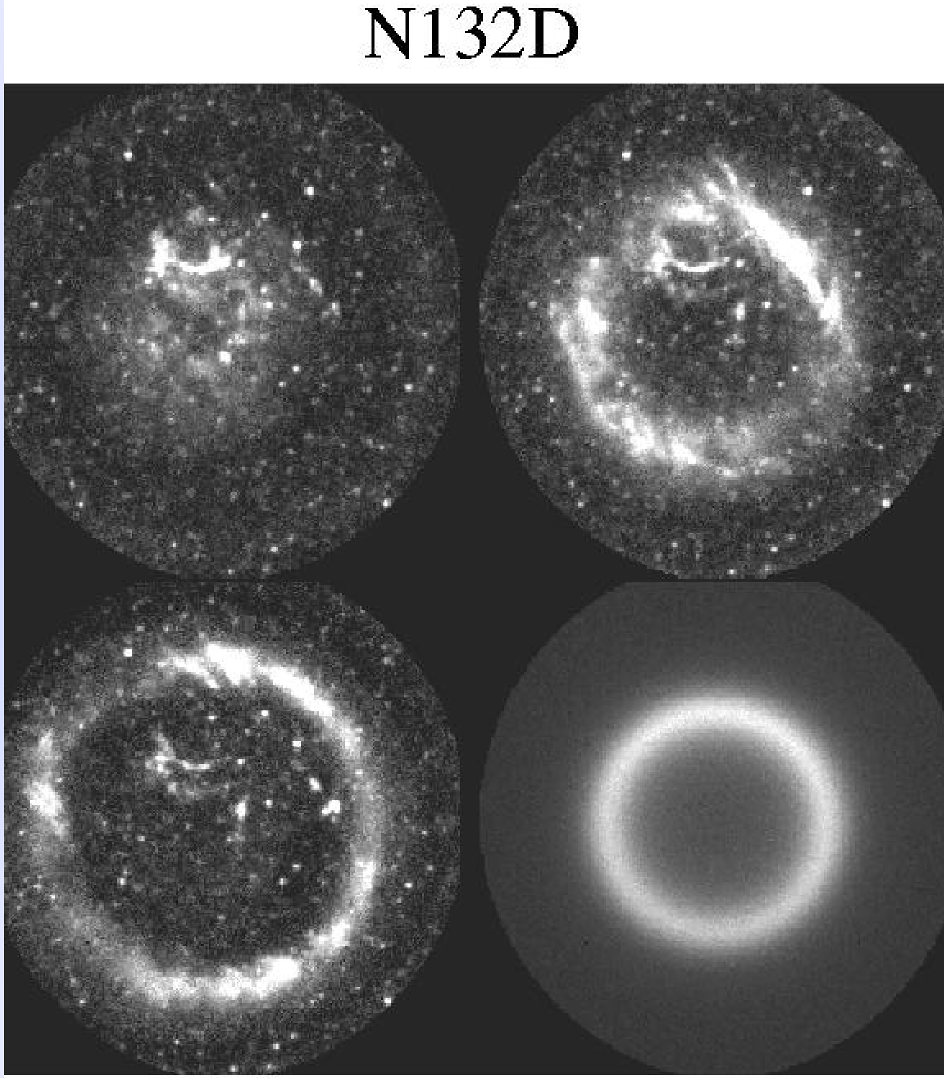


• Full-field kinematics distinguish fast-moving, O-rich ejecta from shocked ISM gas.

• These views show the data cube from the top and the side.
• For simple inertial expansion, velocity can be converted to third spatial dimension for full 3-D structure.
• Note: This data cube has been Phase Corrected for velocity curvature in raw images - ie., the ambient line emission at λ5007 has been straightened and the variable sky level from each separate image is now curved. Data were obtained over multiple nights as qtr Moon set.



- Individual raw images showing stationary nature of diffuse emission.
- Emission in bright shocked filaments has broad velocity dispersion and appears at multiple etalon settings.
- Unresolved HeNeAr line (He I λ5015) is shown for comparison at lower-right.



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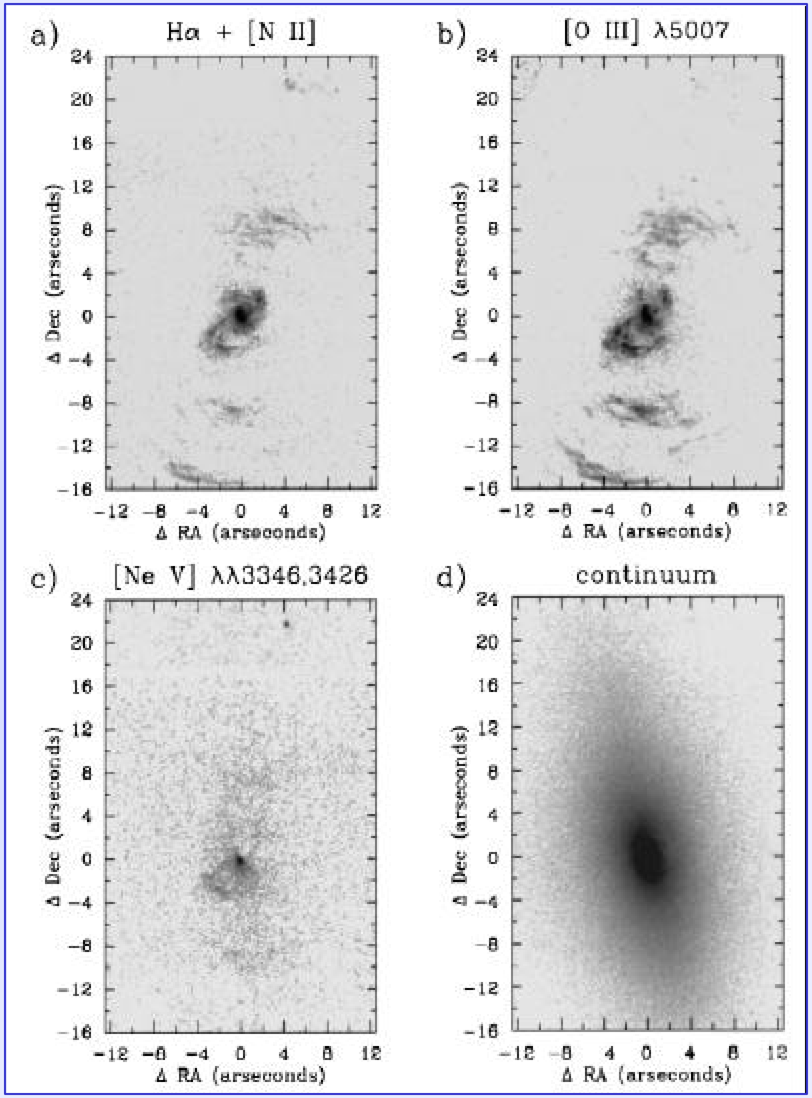
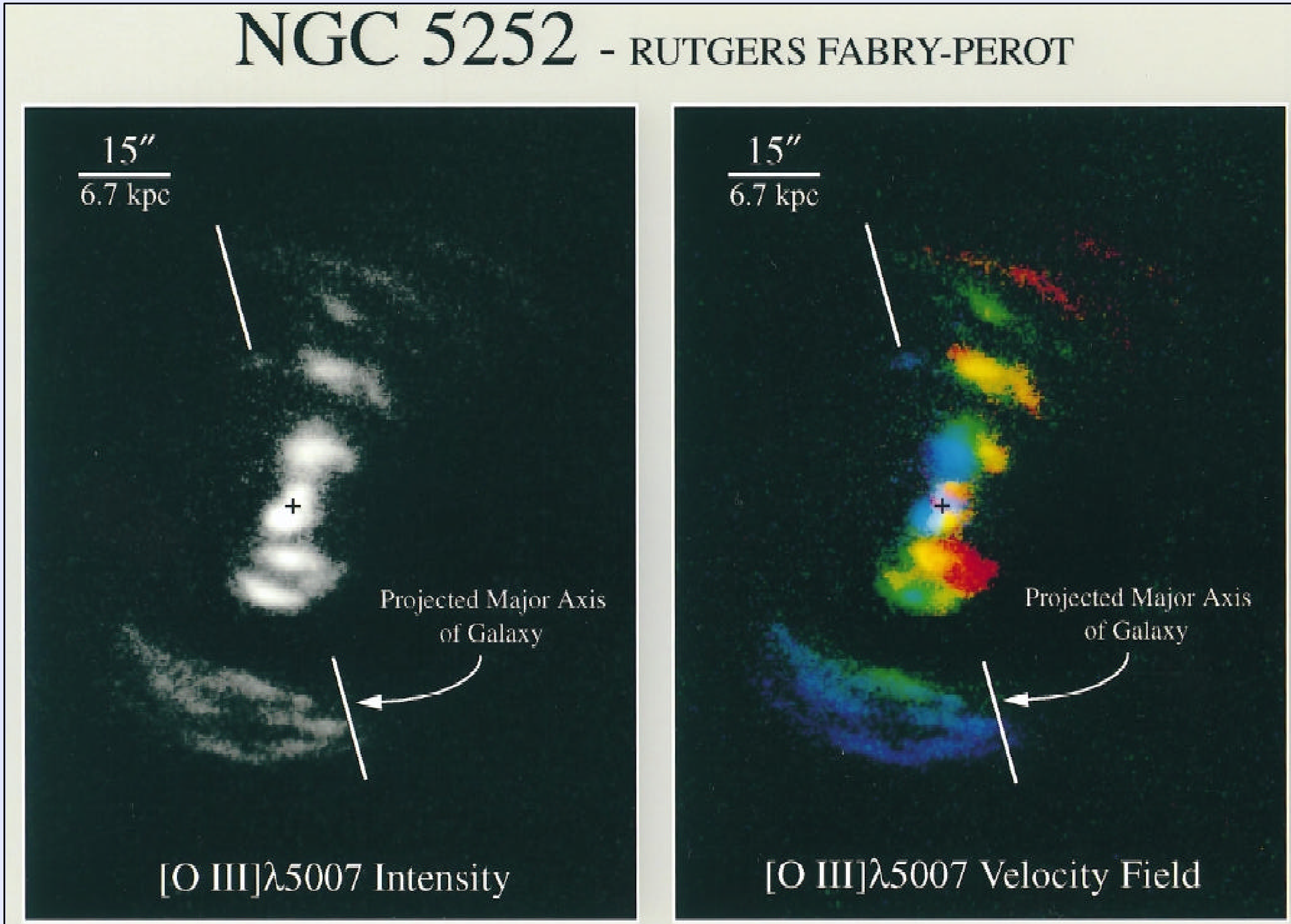
<u>Example:</u>

- NGC 5252 from Morse et al. (1998).
- Seyfert 2 nucleus with ionization cones embedded in S0 galaxy.
- HST images show fine detail in gaseous filaments.
- Ionization cones extended ± 1 arcmin (± 25 kpc) from nucleus.



- Full-field kinematics eveal two separate gaseous disks rotating t large projected ngles from each other (and from the tellar disk).
- System appears to e the result of a nerger with a mostly gaseous companion.



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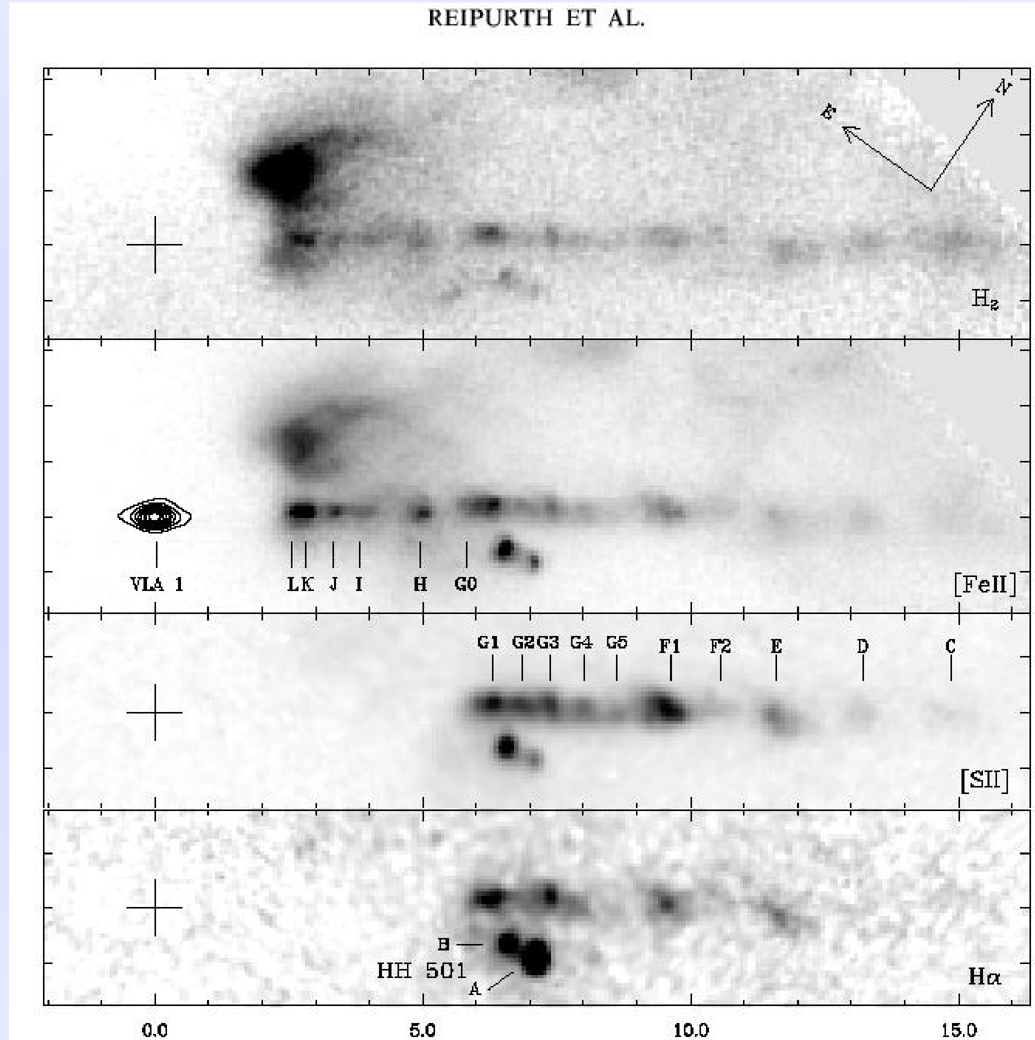
<u>Example:</u> The value of the near-IR

• HH 1 protostellar jet can be traced much closer to the source in [Fe II]λ1.64 microns than in optical lines such as Hα or [S II].

• H_2 traces interactions with ambient molecular cloud material (or may even be present in high-velocity jet).



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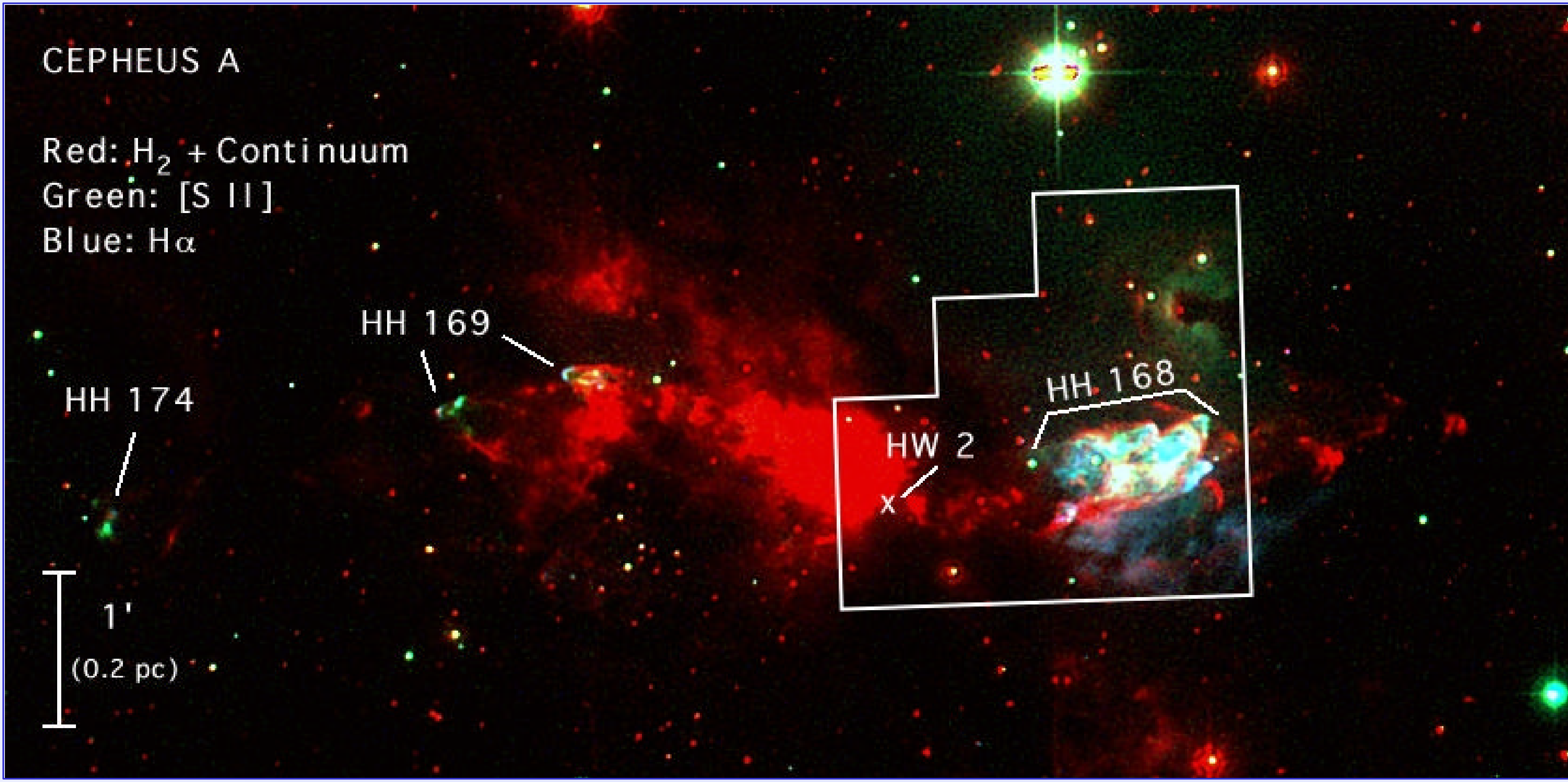
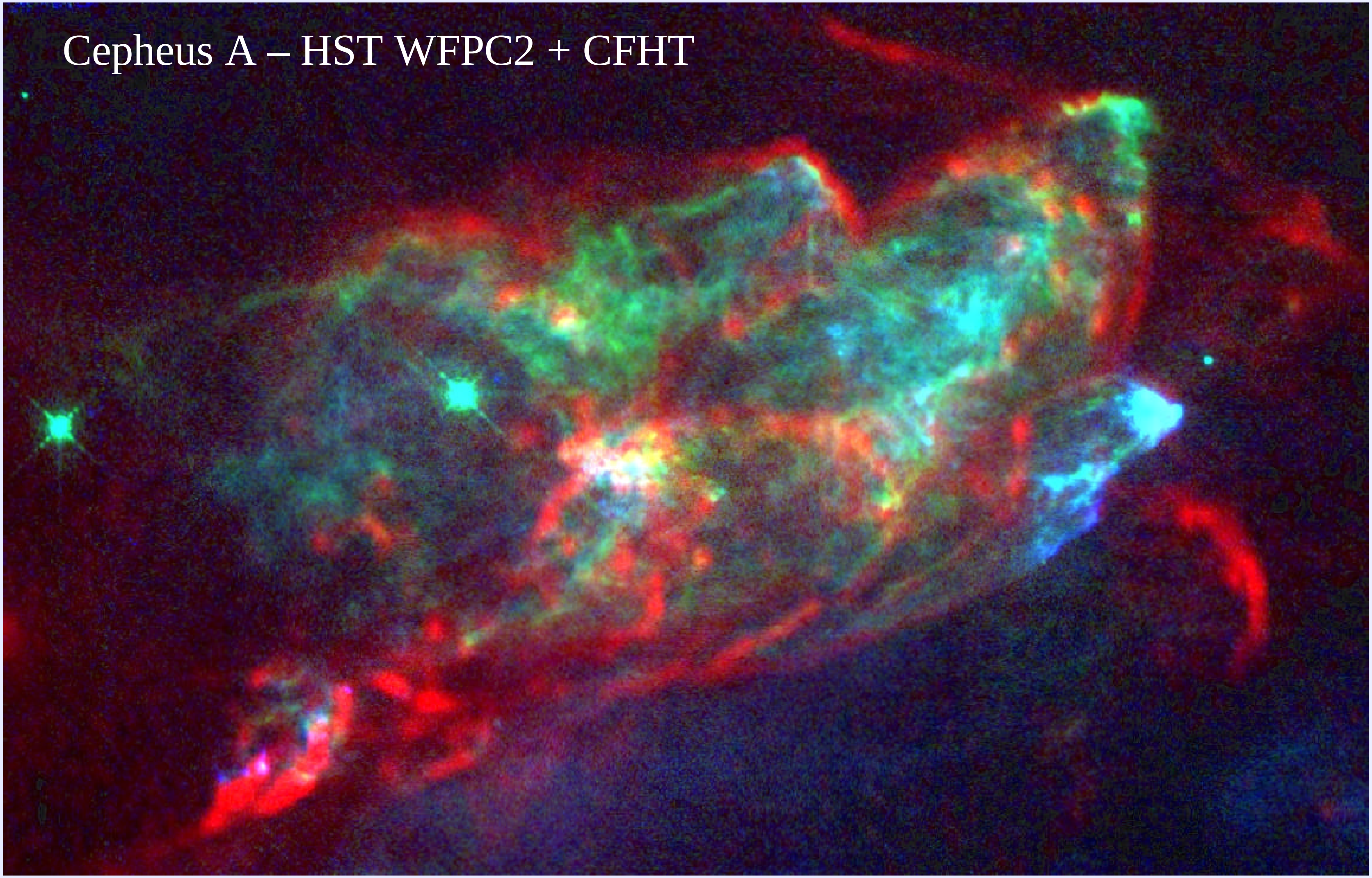


Example: Cepheus A star forming region with large bipolar outflow.

Hartigan et al. 2001

Hα
[S II]
H_2



• CFHT cryo-echelle long-slit spectrograms of Ceph A knots and filaments in H_2 emission.

• R ~ 10,000 spectral resolution needed to decipher H_2 flows.

• IR F-P imaging will reveal full field kinematics more efficiently than stepping a long slit, and with seeing-limited angular resolution.