Three-Dimensional Kinematics of the OSNR G292.0+1.8

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Session V - SNRs and their Environments

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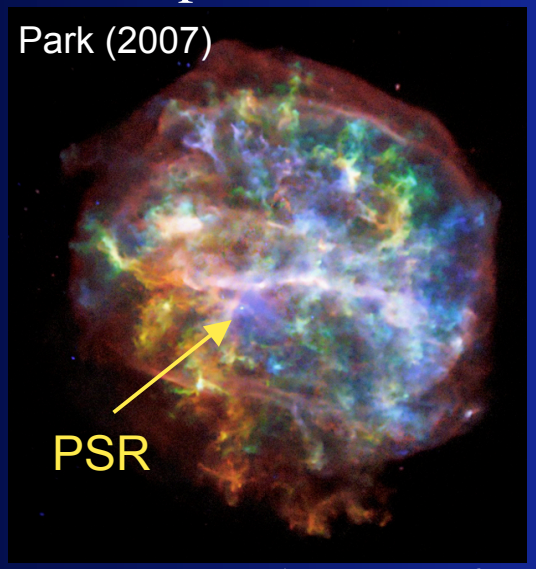
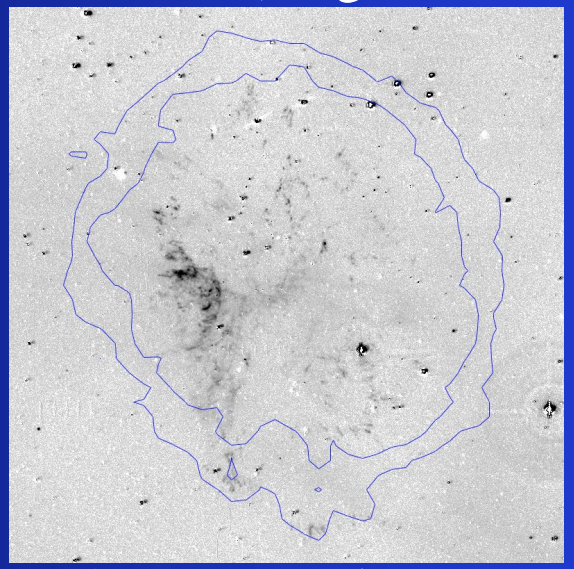
O-SNR G292.0+1.8 (MSH 11-54)

- Displays expected results of core-collapse SNR:
  - O-rich optical knots, and no H => pure ejecta (Goss 1979)
  - X-ray emission enriched by heavy elements (Park 02, 04)
  - Apparent circumstellar interaction
  - Active pulsar and associated PWN (Hughes 01, Camilo 02)

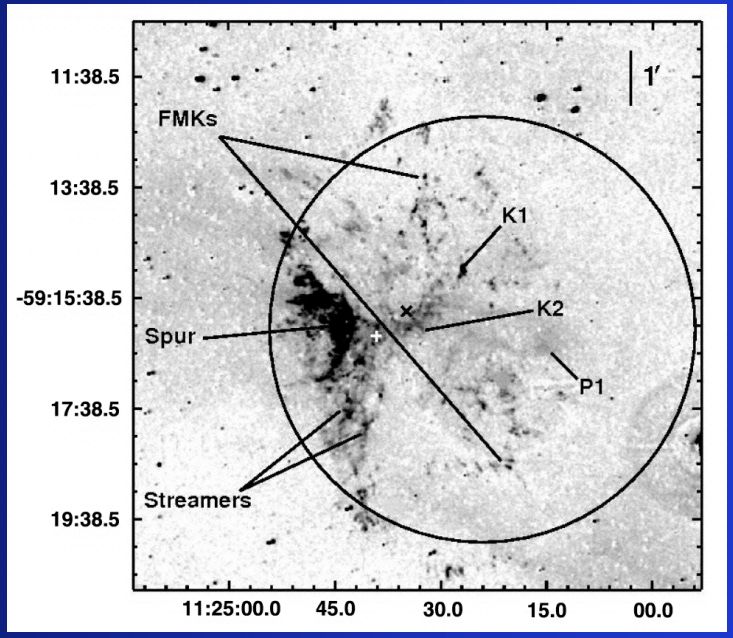




- Diameter 8', Distance 6.2 ± 0.9 kpc (Gaensler 03)
- Kinematic age 2990 ± 60 yrs

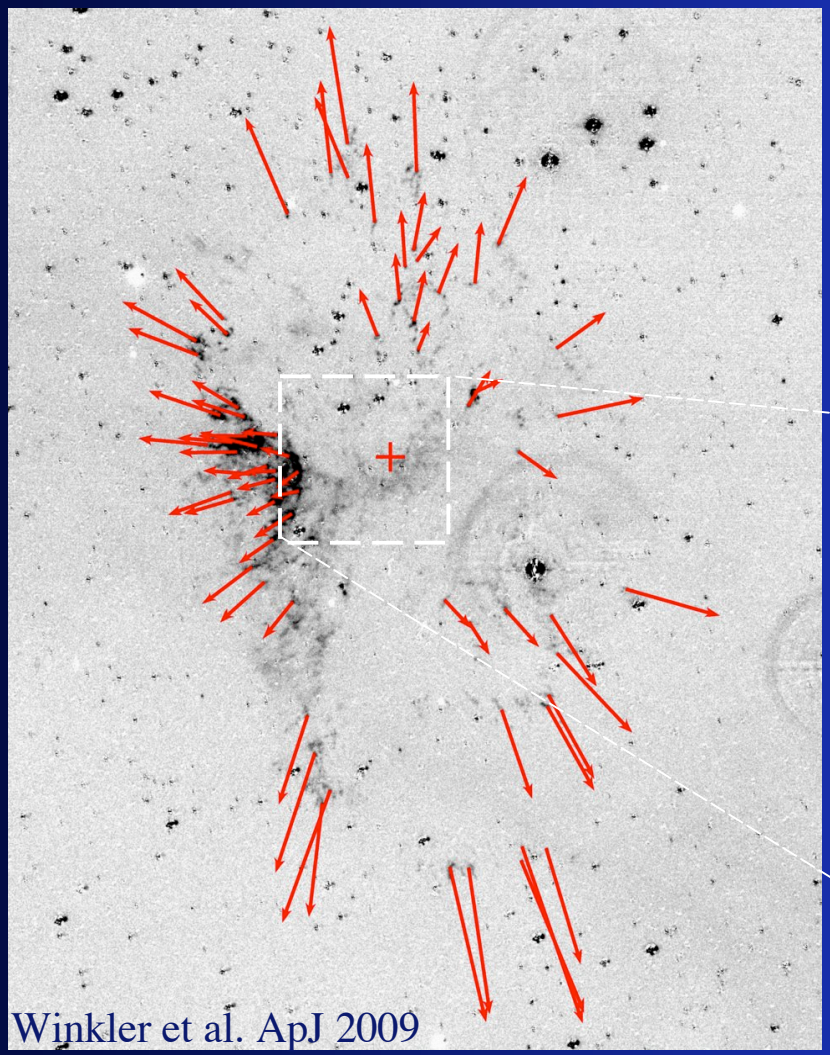
Recent Kinematic Studies

- Fabry-Perot scans of [O III] 5007 Å emission (Ghavamian 05)

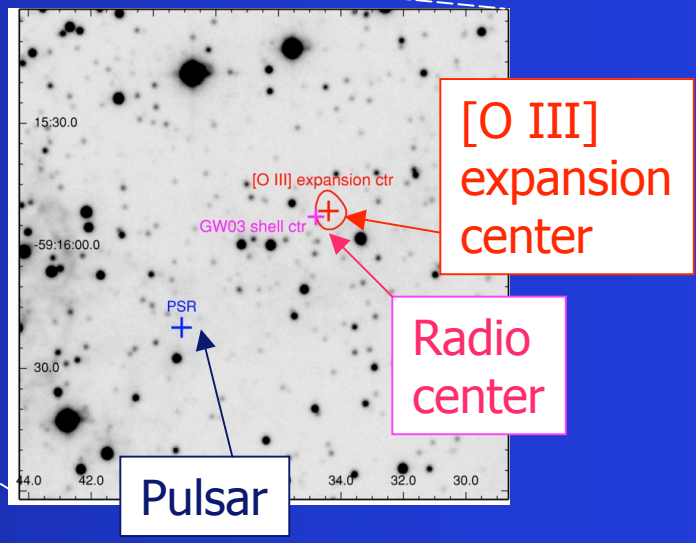


- Imaging from 1986-2008 used to measure proper motions of 67 knots (Winkler 09)

Recent Kinematic Studies



- Left: Continuum-subtracted image shows expansion center and proper motions of 67 filaments projected forward 1000 years. Expansion rate indicates age of 2990 ± 60 yrs.
- Below: 2′ section of unsubtracted [O III] 5007 image shows PSR J1124-5916. PSR transverse velocity is 440 km/s.



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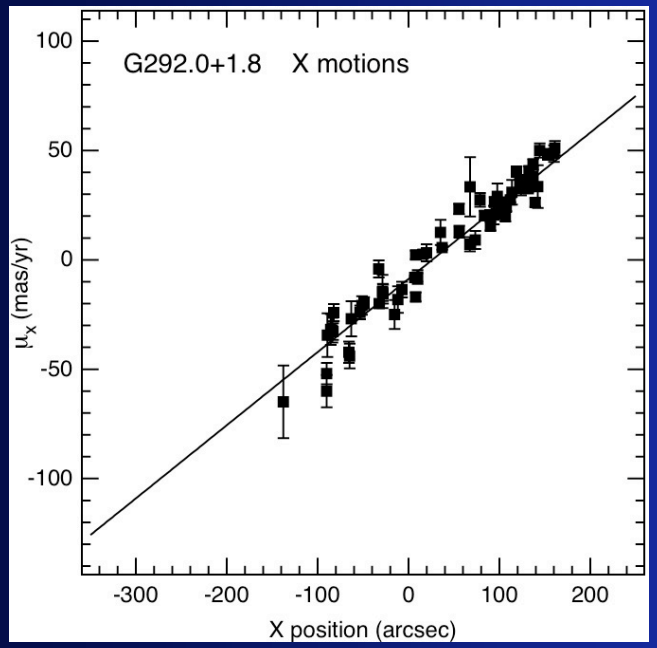
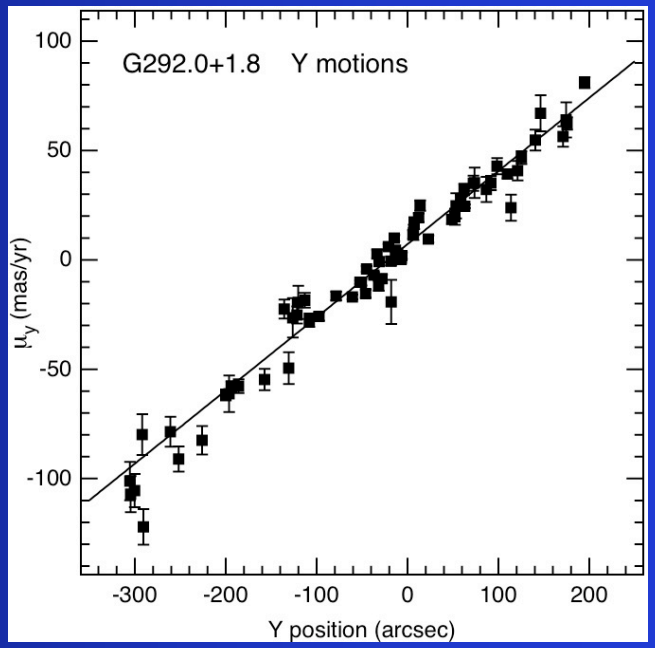
Proper Motions

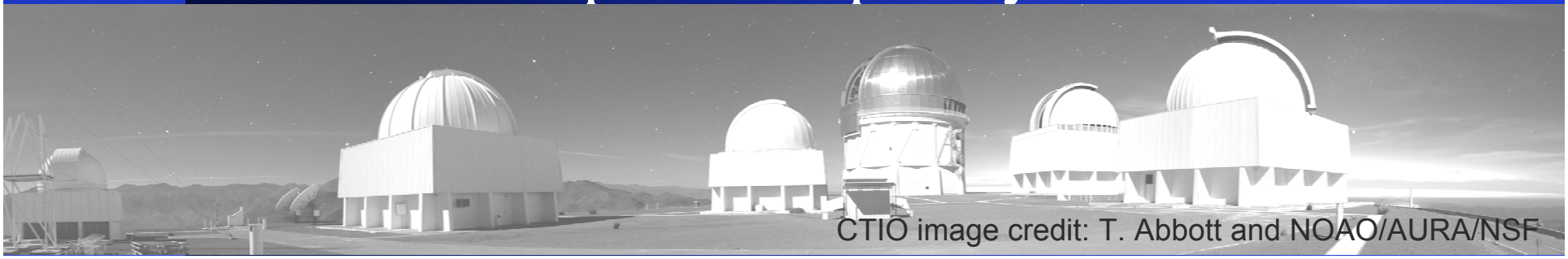




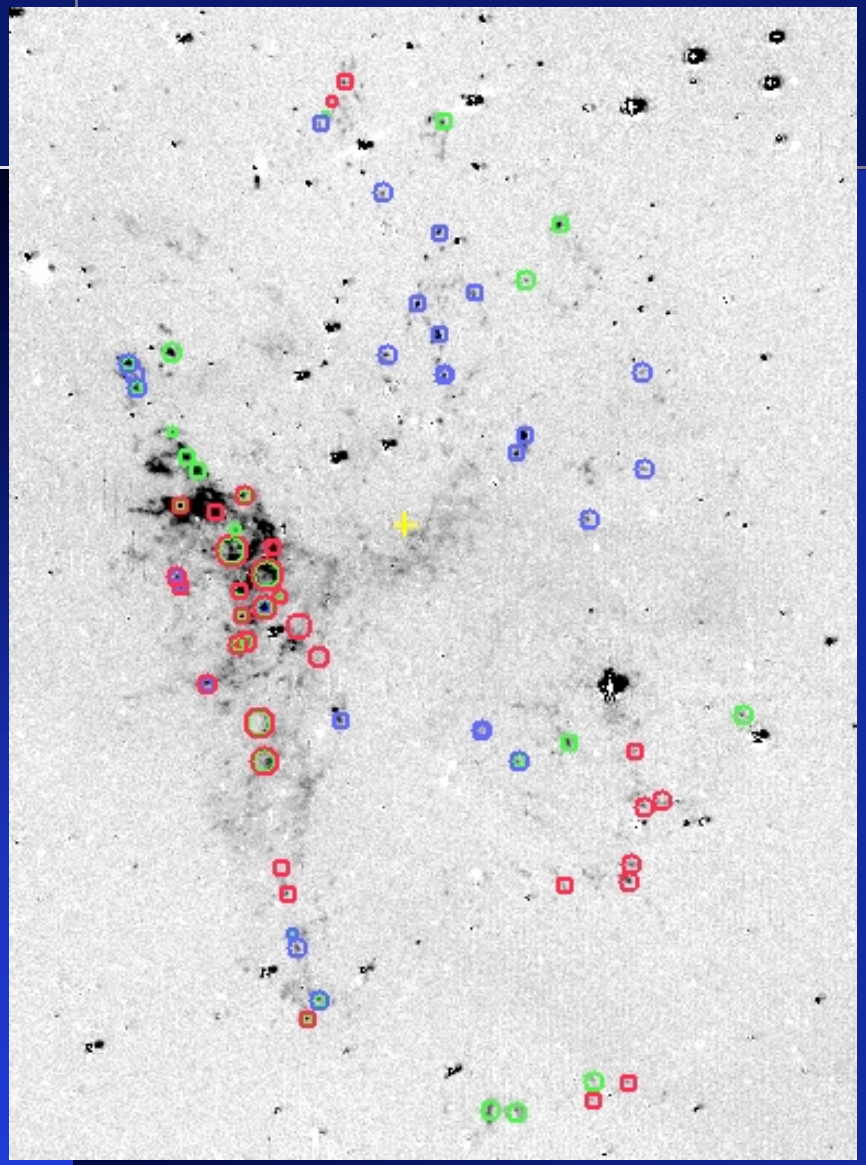
- For all knots, distance traveled from the common expansion center is proportional to its velocity.
- All identifiable knots seem to be ejecta fragments un-decelerated since launch.
- Assuming un-decelerated expansion, radial velocity is proportional to distance from center along the line of sight.

New Optical Spectroscopy

- CTIO 1.5m telescope, 2006
  - Ritchey-Chrétien (RC) spectrograph
  - Long-slit spectra for five slit positions, 45 knots
- CTIO Blanco 4m telescope, 2008
  - Hydra multi-object spectrograph
  - 3 fields observed, 69 knots
- Total: 93 spectroscopically distinct knots



CTIO image credit: T. Abbott and NOAO/AURA/NSF



Blue: $v_{rad} < -300$ km/s

Green: $-300 < v_{rad} < +300$ km/s

Red: $v_{rad} > +300$ km/s

Total v_{rad} range:
–1400 to +1600 km/s

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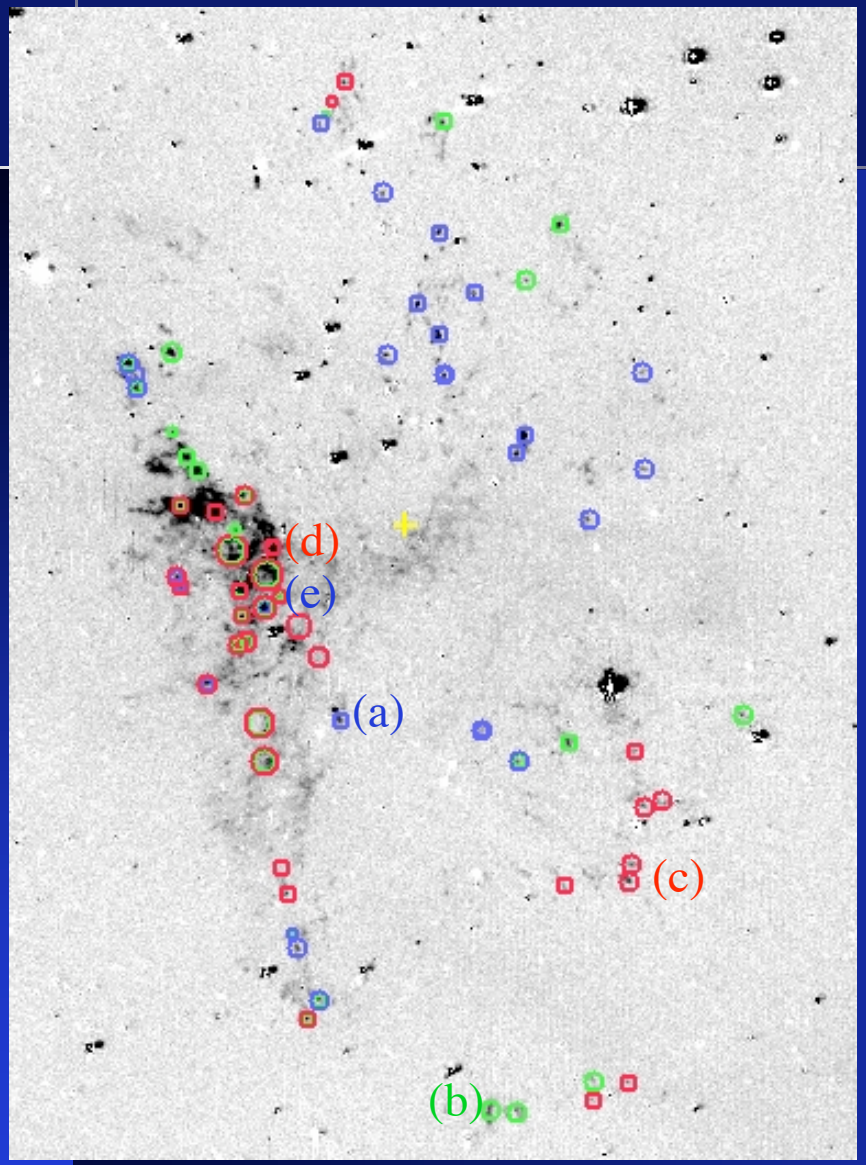

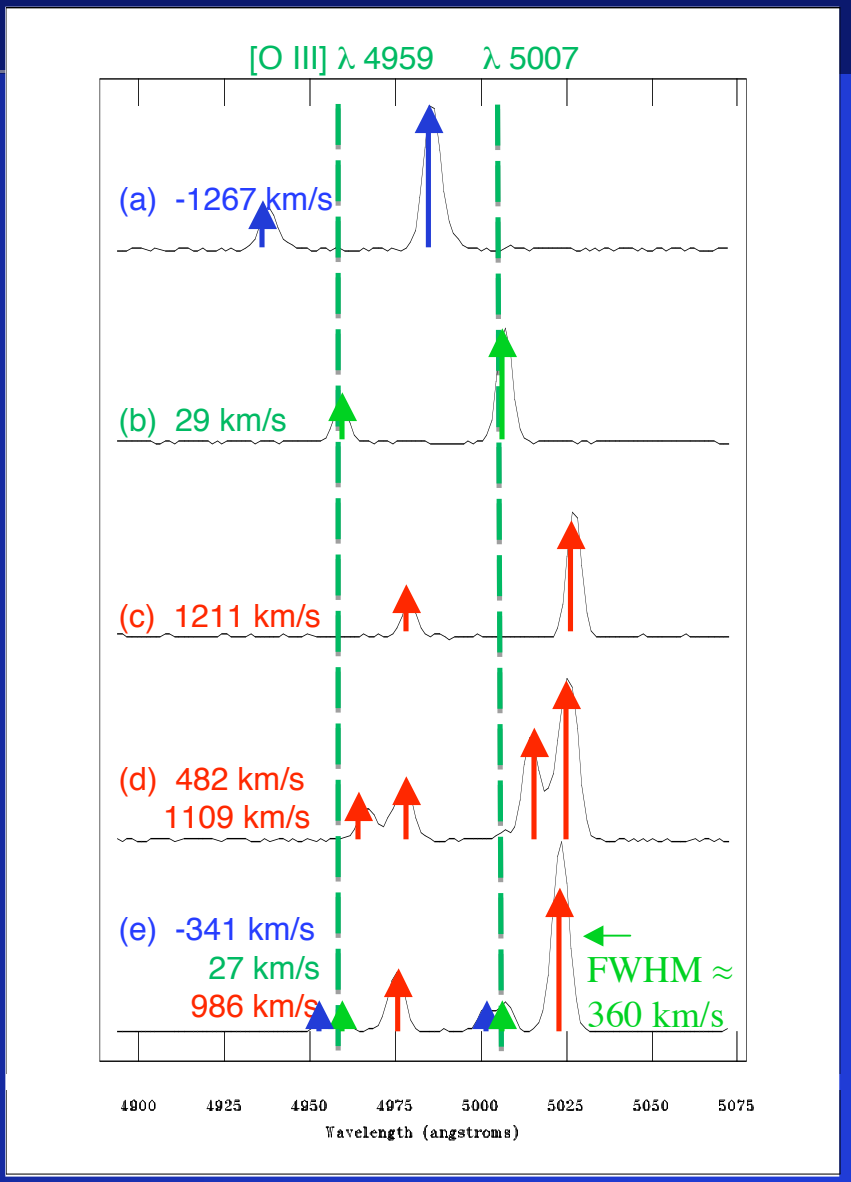

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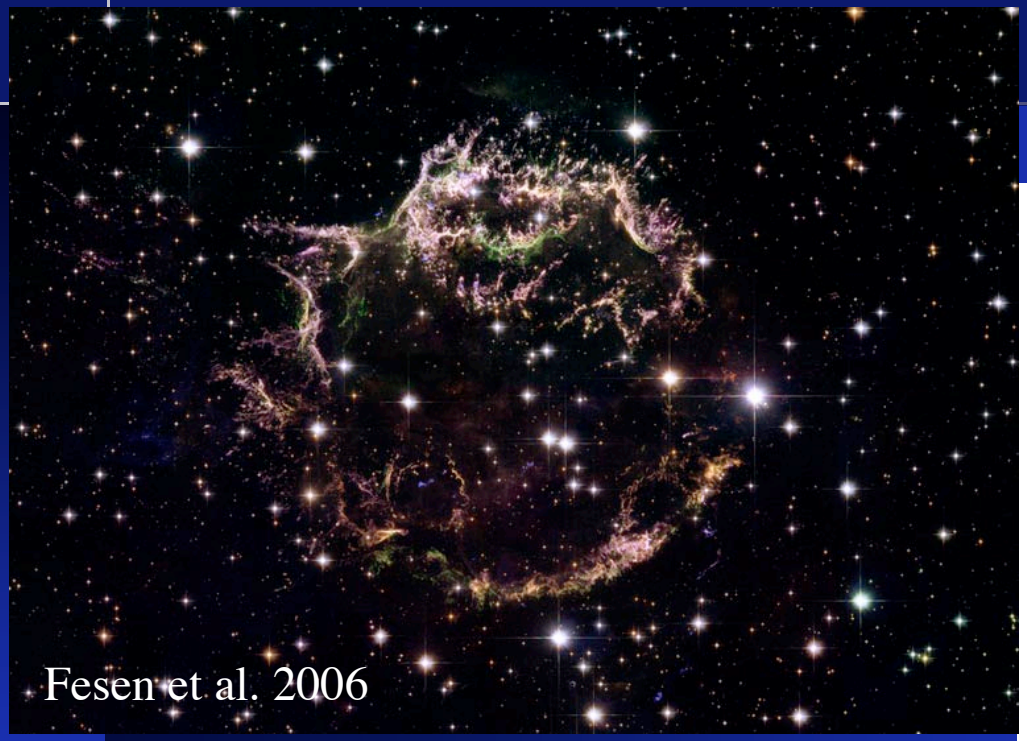
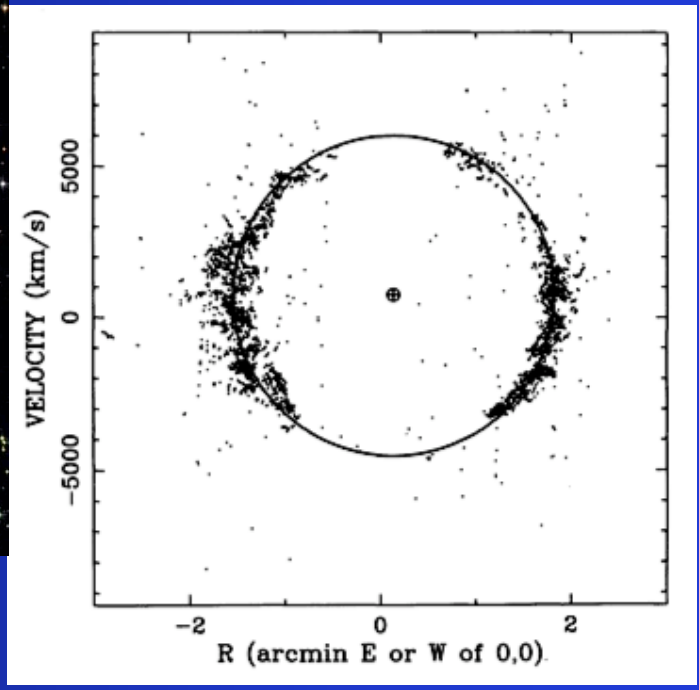
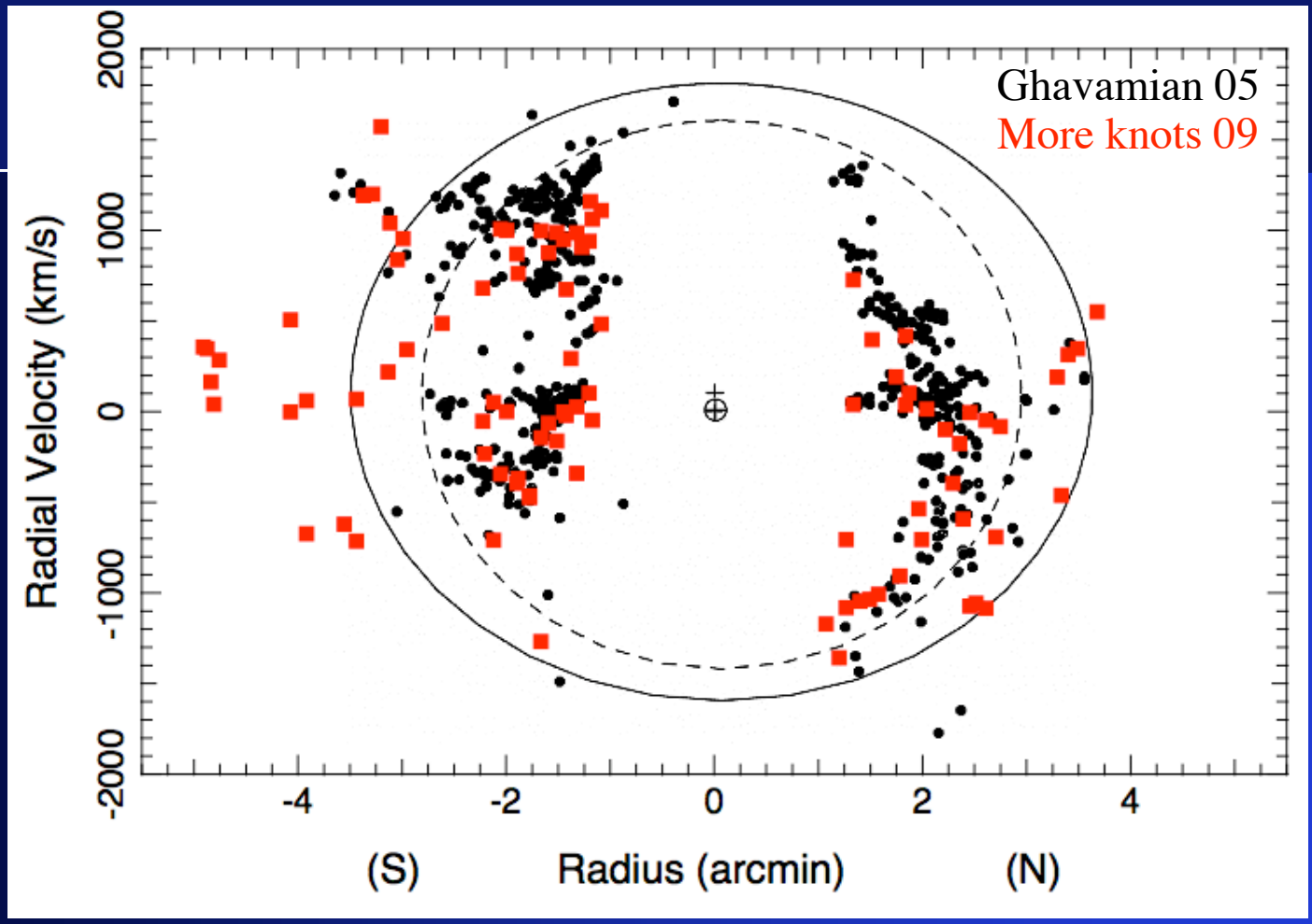
Three-Dimensional Structure - Cas A





- For Cas A, most ejecta knots lie near a spherical shell, plus jets of much faster material; systemic radial velocity ~ + 770 km/s (Reed 95)
- See 3-D models by Tracey DeLaney
- Do similar patterns persist in G292 (~ 10 x older)?

Three-Dimensional Structure



- Outer Fast-Moving Knots (mostly) lie near spherical shell? (Ghavamian 05)
- Systemic radial velocity is small (~ +100 km/s, Ghavamian 05)
- More distant (faster) knots lie far outside posited shell to the South

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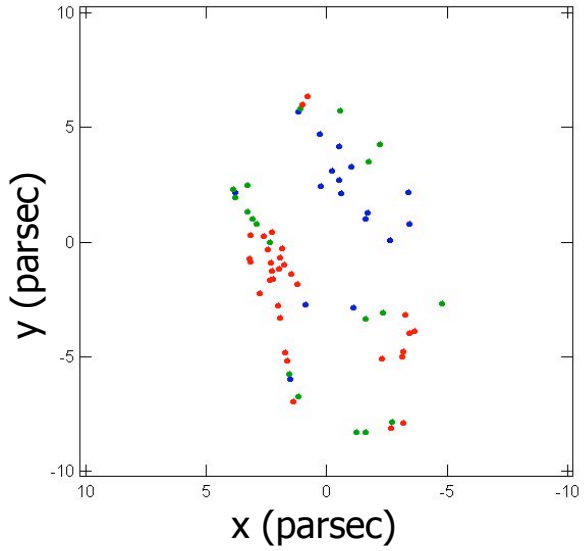
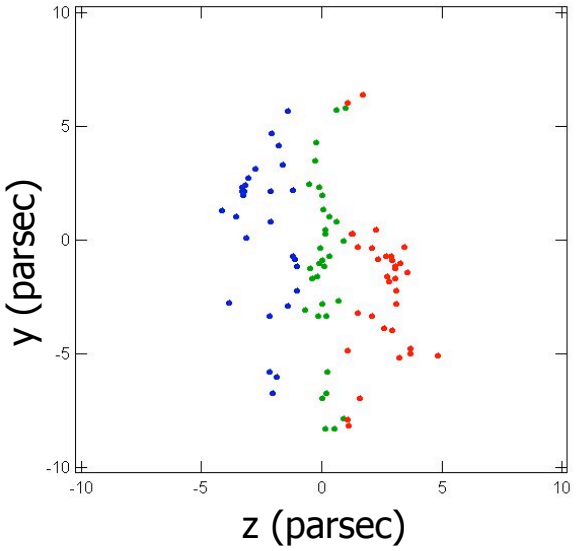
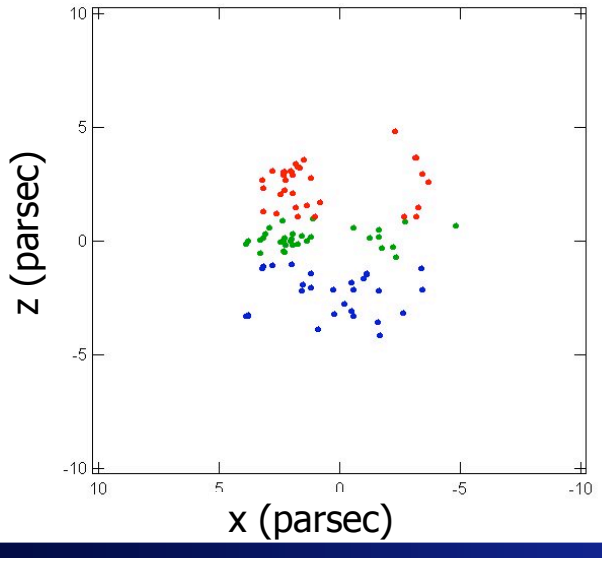
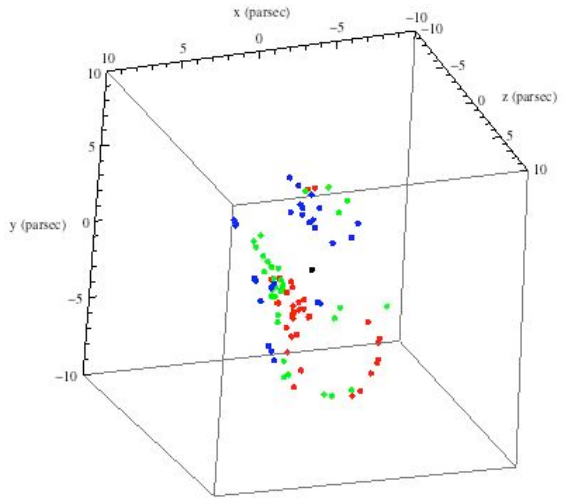
Three-Dimensional Views









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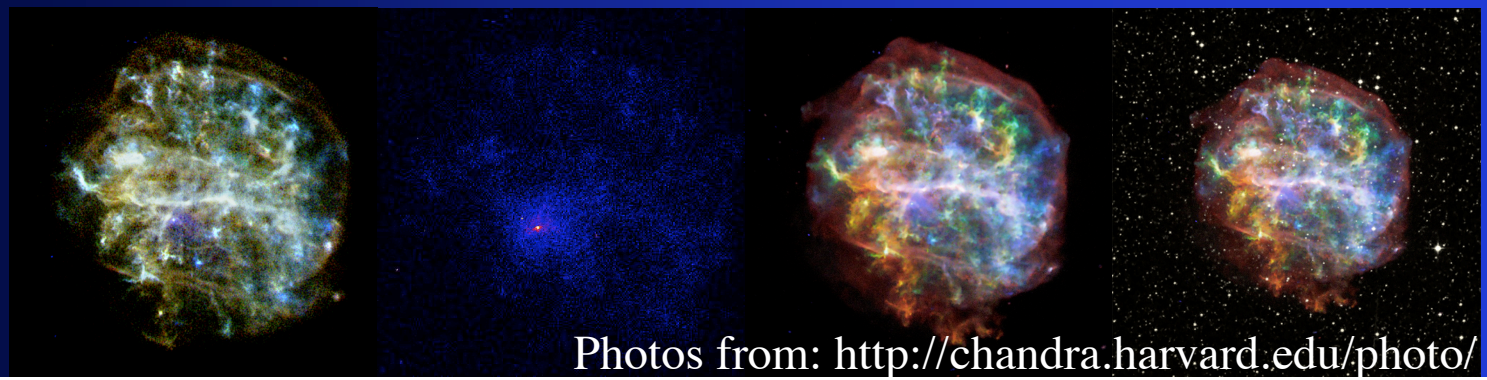
Summary

- Proper motions indicate un-decelerated ejecta material
- Measurements of line-of-sight velocity allow us to construct a 3-D picture of the SNR
- Velocity and morphology of knots more complicated than seen in Cas A; we can make a 3-D image similar to those by DeLaney (see previous talk in Session V)
- Bi-polar/conical structure of knots expanding outward from center, reminiscent of structures presented by Fesen (3C 58) and Burrows (see Sessions III and IV)



Photos from: http://chandra.harvard.edu/photo/