Near-infrared line imaging of supernova remnant

: Background study: Wide infrared IFU observations of G11.2-0.3

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IoA

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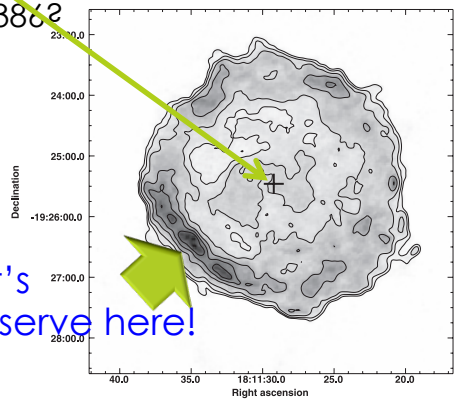
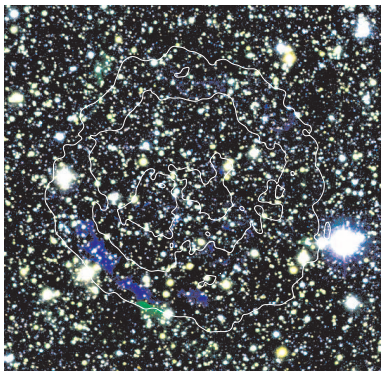
Motivation

- Origin of bright [Fe II] emission of G11.2-0.3
  - Bright clumps around shell : Circumstellar materials (CSM)
  - High velocity (100 km/s) knots around center : Ejecta

Position of pulsar
SN AD386?



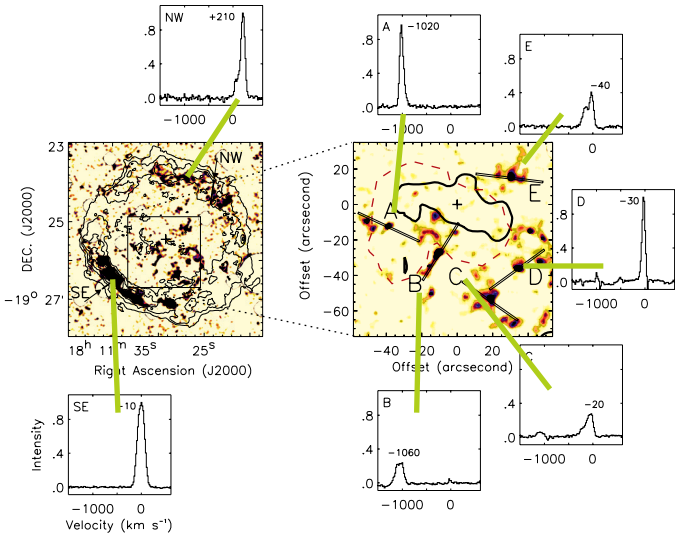
Let's observe here!



VLA 20cm;
R ~ 3 pc (at d = 5 kpc)
(data from Green 1988)

Palomar K:H2:[Fe II]

(Koo et al. 2007)



Palomar long slit follow-up
(Moon et al. 2009)

Early works (SNRs)

- Shock model (Hollenbach & McKee 1989)
  - [Fe II] is strong near-IR line in shocked medium
- First [Fe II] detection of SNR (Seward et al. 1983)
  - MSH15-52; [Fe II] intensity is comparable to Hß intensity
- Graham et al. (1987, 1990)
  - IC443, Crab
- Oliva et al. (1989)
  - RCW103, Kepler, N63A, N49, N103B
- More observations
  - Cas A, Kepler (Gerardy & Fesen 2001), 3C391, W28, W44 (Reach et al. 2002, 2005), W49B (Keohane et al. 2007), G11.2-0.3 (Koo et al. 2007, Moon et al. 2009), 3C396 (Lee et al. 2009)

Integral field unit (IFU) observations of G11.2-0.3

- IFU observations
  - FISICA + FLAMINGOS on Kitt peak 4m telescope
  - Image slicer : FISICA (works like 21 long-slit spectrographs at a single exposure)
  - FoV = 16″ x 33″ !

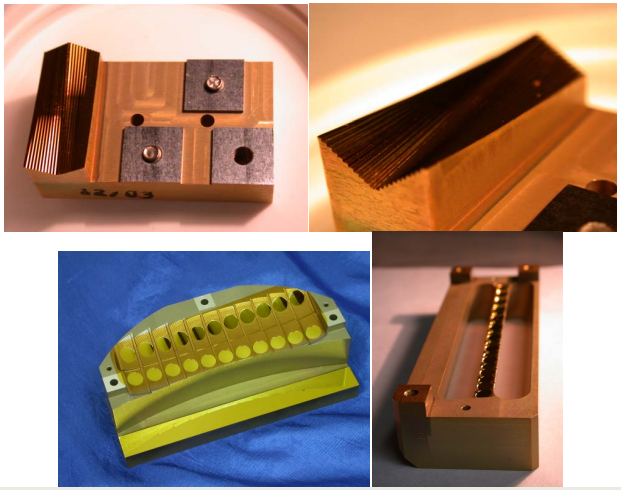
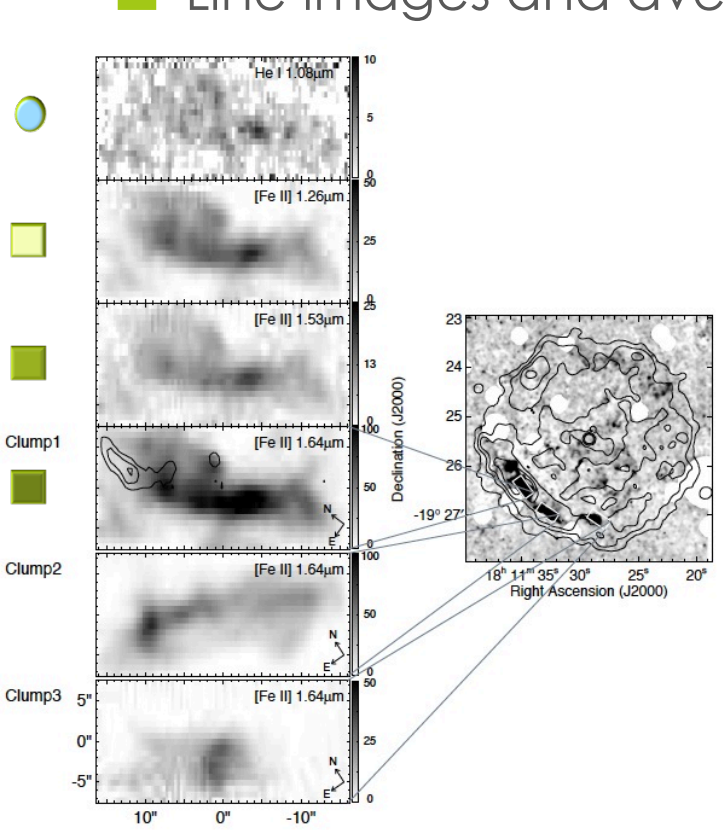


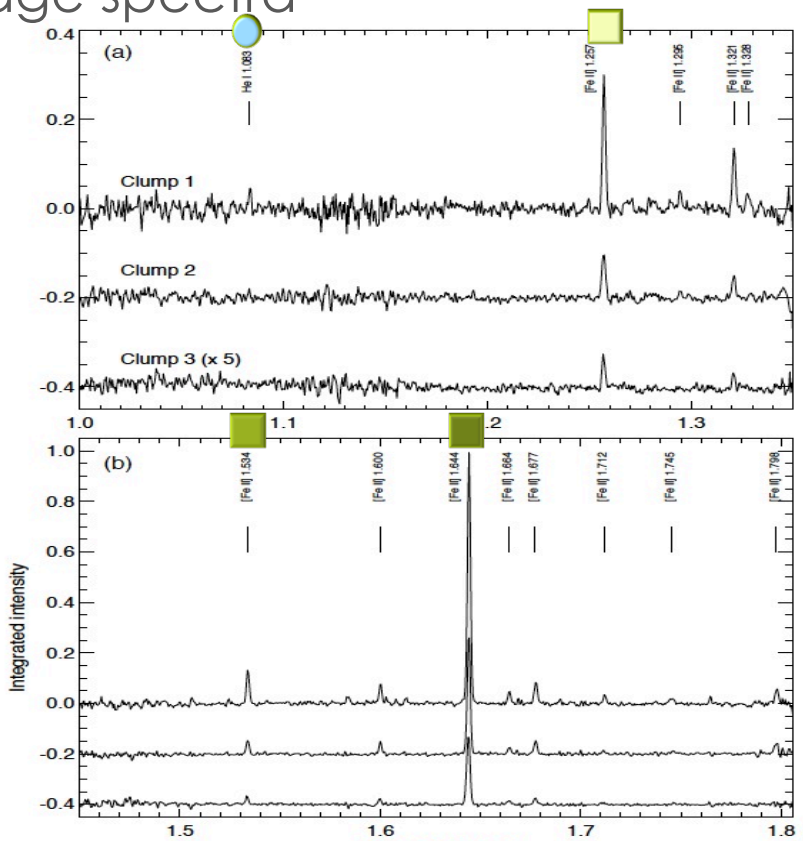
Image reconstruction

- Gaussian fit at each pixel , JH bands

Images & spectra

- Line images and average spectra



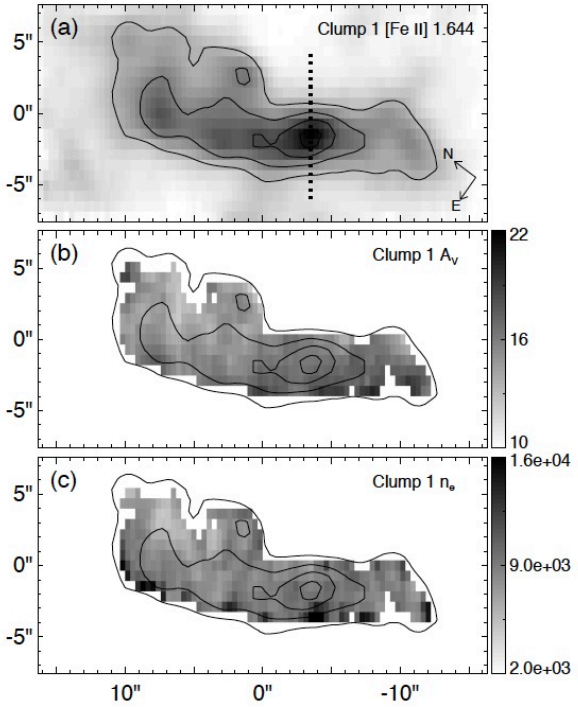


Bright structure

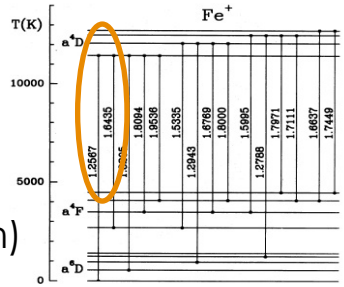
- Long filamentary shell
  - Almost entire SE part of shell (a quarter of entire shell)
    - Clumps 1, 2, 3
  - Rest velocity
    - Velocity < 150 km/s (unresolved by R ~ 1500)
  - Simple structure
    - Bright peaks in the middle of shell
  - Similar morphologies at all line images
- Consistent with result of SNR shock covering entire SE region
  - Supports CSM origin

Properties of clump1

- Bright enough to provide distributions in several transitions

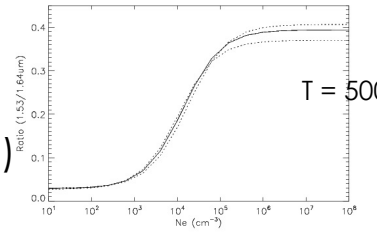


I(1.26)/I(1.64um)



(Transition diagram Oliva et al. 1990)

I(1.53)/I(1.64um)



T = 5000 – 10000 K

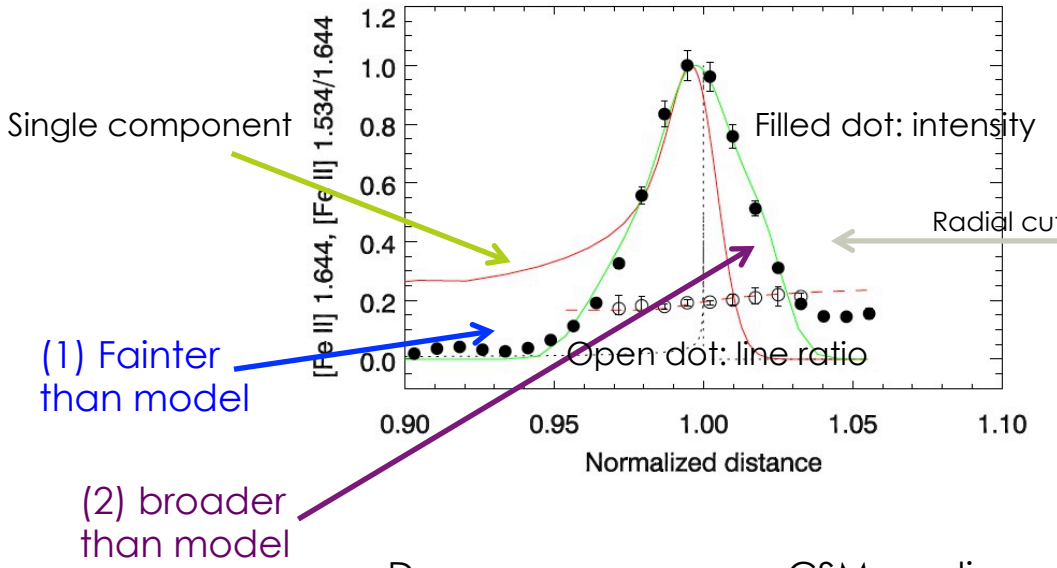
Properties of clump (II)

- No correlation between intensity and n_e (or Av)
  - Variation of extinction (Av) at southern area
  - Electron density (n_e) is similar through out the clump1
    - High densities around the edge of clump1
    - Effect of Av is small for n_e distribution
- Average values

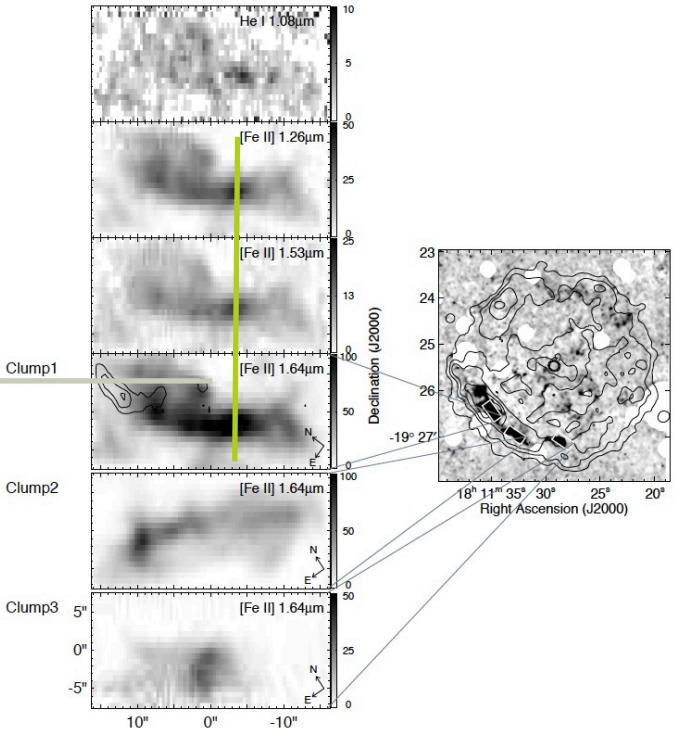
	Clump1	Clump2	Clump3
Visual extinction	16 ± 1	18 ± 1	20 ± 1
Electron density (cm-3)	9400 ± 2100	8100 ± 2800	4700 ± 1000

Radiative model for radial profile

- Results of shock model



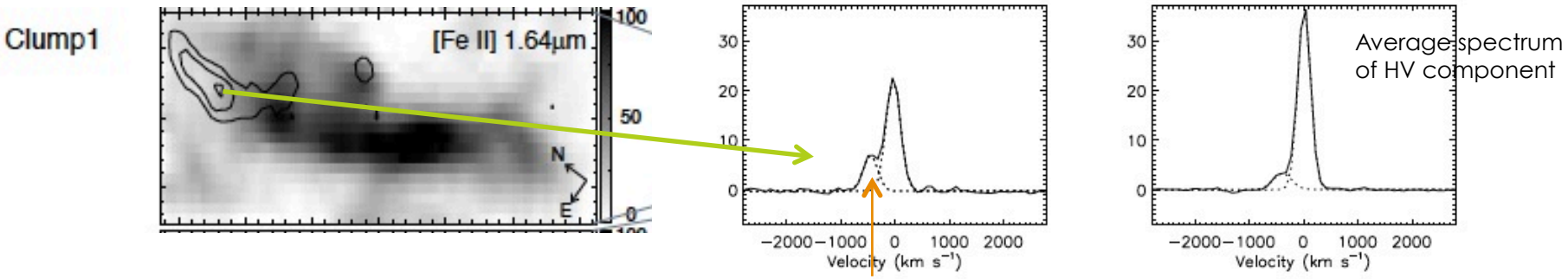
Dense pre-supernova CSM medium:
(1) localized (2) multi-shells



Near-IR IFU line images of G11.2-0.3
(Lee et al. in preparation)

High velocity component

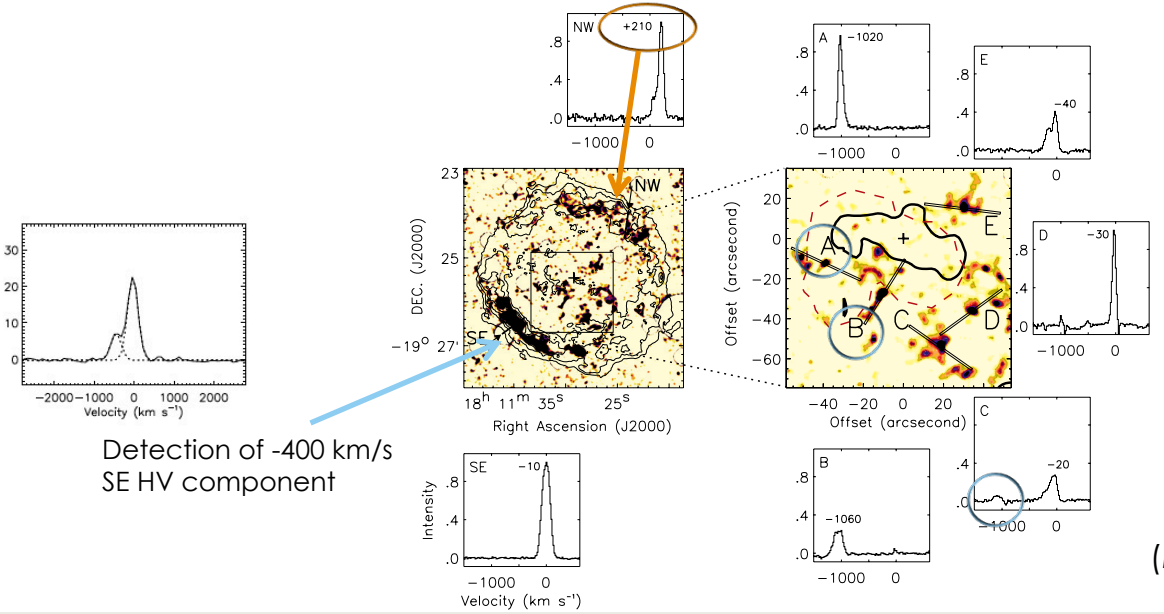
- Contribution by ejecta?
  - Flux of HV component : ~ 4 % of total flux
    - We detect only bright, fast, separated ones
    - Cannot totally exclude a possibility of CSM + ejecta
- Observed velocity ~ 400 km/s
  - Moving speed (de-projected v) can approach to 1000 km/s



Bipolar distribution?

- NW : redshifted component
- SE : blueshifted component

} Hint for bipolarity of SN explosion?



(Moon et al. 2009)

Summary

- Spectral cube data of southeastern filament of G11.2-0.3
  - Line images
  - Spectra
- We obtain n_e & Av maps
  - Their distributions are different from those of line images
- Comparison with model calculation of bright structure : CSM
- High velocity component : ejecta
  - Hint for bipolarity of SN ejecta distribution
- ➔ We want to know chemistry!!!
  - MiniTAO imaging of Pa α (, Pa β)