Near infrared IFU and MOS observations of supernova remnants

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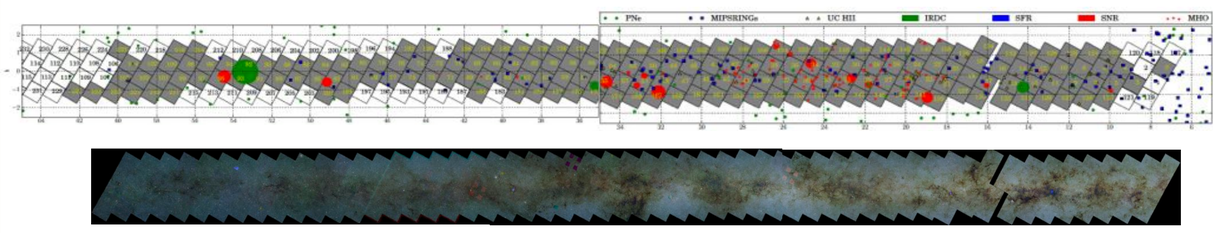
Abstract

We present near-infrared integral field unit (IFU) and multi-object spectroscopy (MOS) observations of two bright [Fe II] line emitting supernova remnants (SNRs). The two SNRs, G11.2-0.3 and RCW103, are selected from our near-infrared [Fe II] 1.64 um narrow band imaging survey of SNRs such as UKIRT unbiased [Fe II] imaging survey of the the Galactic plane and AAT [Fe II] imaging of some core-collapse SNRs. We detect several near-infrared hyperfine lines of [Fe II] at the southeastern shell of G11.2-0.3. We estimate the line strength and extinction-corrected density, which gives a clue to the origin of the iron-rich southeastern shell of G11.2-0.3. We obtain the MOS spectra of [Fe II]-emitting clumps inside RCW103. The observed clumps move about hundreds kilometers in radial direction, suggesting that they are shocked dense materials lost by stellar wind at the final stage of the evolution of the progenitor star..

[Fe II] line emitting SNRs

❖ UWIFE [Fe II] survey (Lee, J.-J. et al. 2014, northern sky)

- [Fe II] 1.64 μm narrow band imaging survey (gems0.kasi.re.kr/uwife/)
- 7° < *l* < 62°, -1.5° < *b* < 1.5°
- Identified SNRs : see poster S10.10 (Lee, Y.-H.)



❖ AAT [Fe II] imaging of selected SNRs (southern sky)

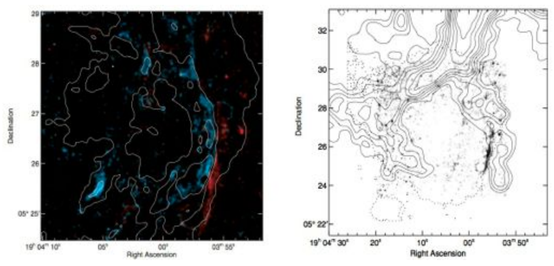
- [Fe II] 1.64 um narrow band imaging using AAT/IRIS2
- Some SNRs SNRs with size of < 10’

Name	Imaging	Spectroscopy
MSH15-52	[Fe II], H	Long-slit
G292.0+1.8	[Fe II], H	-
RCW103	[Fe II], H	MOS
G340.6+0.3	[Fe II], H	Long-slit
G344.7-0.1	[Fe II], H	Long-slit
G337.8-0.1	[Fe II], H	Long-slit
3C397	[Fe II], H	MOS
Some SNRs in LMC	[Fe II], H	Long-slit, slit mapping

❖ 3C396 (Lee et al. 2009)

- Palomar [Fe II], H_2
- [Fe II] distributes outside H_2
- H_2 along the inner edge of CO cloud

★ Pre-SN CSM shell inside molecular cloud

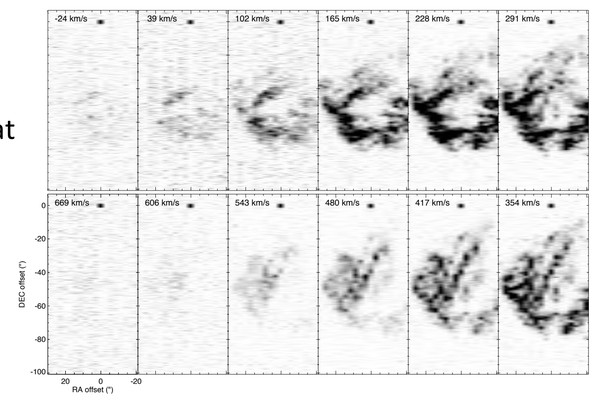


Left: star-subtracted [Fe II] 1.64 (blue) and H_2 2.12 (red) images of 3C396. Contours are radio continuum. *Right*: H2 image with CO contours. Radio boundary is shown by dotted line. (Lee et al. 2009)

❖ N49 in LMC

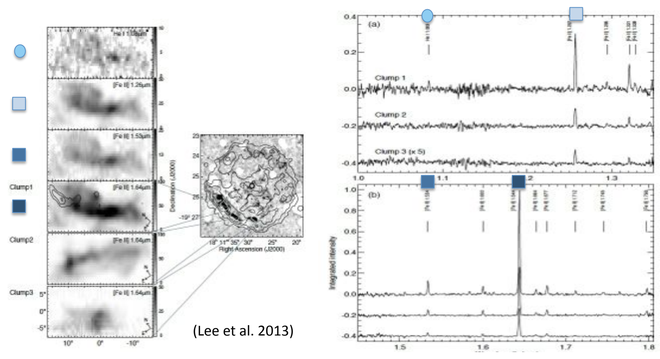
- J & H slit mapping using AAT
- Prominent structures (ring-like at ~200 km/s & triangle 400 km/s)

Near-IR [Fe II] velocity channel maps of N49. These channel maps are constructed from AAT H-band spectral mapping.



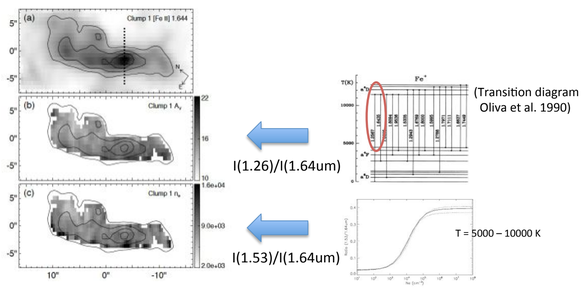
Near-IR IFU observation of G11.2-0.3

❖ IFU images & spectra

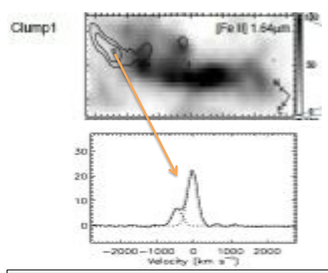


From the left: Line images constructed by our IFU observations. [Fe II] image of G11.2-0.3 with X-ray contours. Average J & H band spectra. (Lee et al. 2013)

❖ Extinction & density maps

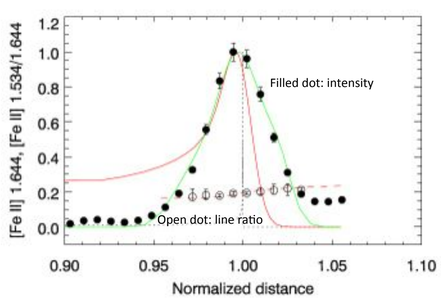


❖ High velocity component



Contours of 2 component gaussian fit of high-velocity (~400 km/s) gas and [Fe II] 1.64 um line spectrum at the peak position.

❖ Radiative model for radial profile

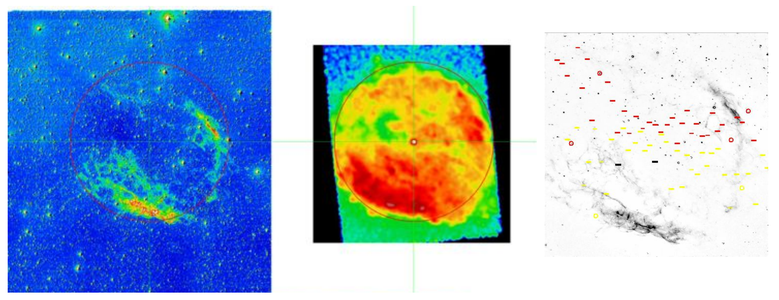


One-dimensional radial profiles of the [Feii] 1.644 μm intensity (filled circles) and the [Fe ii] 1.534 to 1.644 μm line ratio (empty circles) along the cut crossing the peak position of Clump 1. The abscissa is the distance from the central pulsar of G11.2−0.3 normalized by the distance to the shock front.
Black dotted line for [Fe ii] 1.644 μm profile before beam dilution; red solid line for the same [Fe ii] 1.644 μm profile but after beam dilution; red dashed line for beam-diluted [Fe ii] 1.534 to 1.644 μm line ratio profile. The green solid line represents a beam-diluted [Fe ii] 1.644 μm profile from the model calculation of multiple filaments of finite sizes.

★ The observed [Fe II] emission can be explained by shock-heated gas with dense pre-existing CSM in general. But existence of high-velocity ejecta cannot be ruled out.

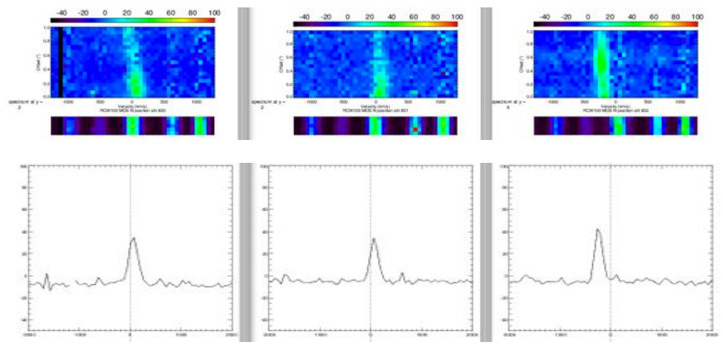
Near-IR MOS observation of RCW103

❖ [Fe II] & X-ray images



From the left: AAT [Fe II] and Chandra X-ray images. Red circle indicates boundary of hot X-ray gas centered at compact central object. Two MOS masks with their slit positions.

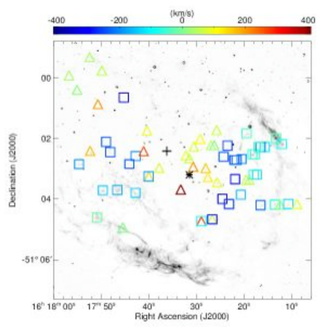
❖ Obtained spectra



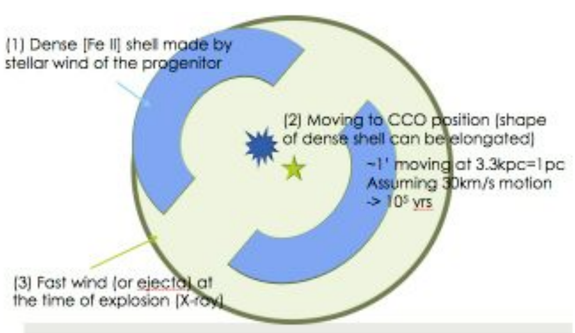
From the top: [Fe II] 1.64 μm 2-D spectra of some representative slit positions. OH lines at the central region of the same slit positions. 1-D spectra with respect to the rest velocity.

❖ [Fe II] motion & center

Center of [Fe II] shell (*) is obtained by elliptical fit of [Fe II] structure. Its offset to CCO is ~1’.



❖ Possible scenario



★ We suggest near-IR multi-positional spectroscopy as a tool to prove pre-supernova condition of the progenitor.