

A Supernova Remnant Candidate in the UWIFE Survey

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Abstract

We report the discovery of a new supernova remnant (SNR) candidate in the narrow-band [Fe II] 1.644 μm line imaging survey UWIFE (UKIRT Widefield Infrared Survey for Fe). UWIFE covers the first quadrant of the Galactic plane ($7^\circ < l < 62^\circ$, $|b| < 1.5^\circ$), and, by visual inspection, we have found ~ 300 extended Ionized Fe objects (IFOs) in the survey area. Most of IFOs are associated with SNRs, young stellar objects, HII regions, and planetary nebulae. But about 12% of IFOs are not associated with any known astronomical objects, and the SNR candidate, IFO J183740.829-061452.41 (hereafter IFO J183740) is one of those.

IFO J183740 is a 6'-long, faint, arc-like filament with small-scale irregular structures. It appears to be a portion of a circular loop, but the rest of the loop is not seen in [Fe II] emission. It is found to coincide with a well-defined radio continuum arc. The radio arc has a complicated morphology, and IFO J183740 coincides with the bright inner part of the radio arc. Hydrogen recombination lines have been detected toward the radio arc from low-resolution surveys, so it has been known as an HII region (G25.8+0.2) at a kinematic distance of 6.5 kpc. But the inside of this radio arc is filled with soft X-rays, while, just outside the arc to the north, there is hard X-ray nebula harboring a young pulsar. Therefore, the nature of this arc-like structure seen in radio and [Fe II] emission is uncertain.

In this presentation, we present the results of follow-up spectroscopic study of IFO J183740 using IGRINS (Immersion Grating Infrared Spectrograph) which is high spectral resolution ($R \sim 40,000$) spectrograph covering H and K-bands, simultaneously. We have found that the [Fe II] filaments are both spatially and kinematically distinct from the HII filaments. The intensity ratios of [Fe II] to Br γ lines suggest that the HII filaments are photoionized while the [Fe II] filaments are shock-ionized, which supports the SNR origin for IFO J183740. We discuss the association of IFO J183740 with other sources in the region.

UWIFE survey

UKIRT Wide-field Infrared Survey for Fe+ (Lee+2014)

Unbiased imaging survey using narrow-band filter with central wavelength of 1.644 μm , covers the 1st Galactic quadrant ($7^\circ < l < 62^\circ$, $b \leq |1.5^\circ|$).

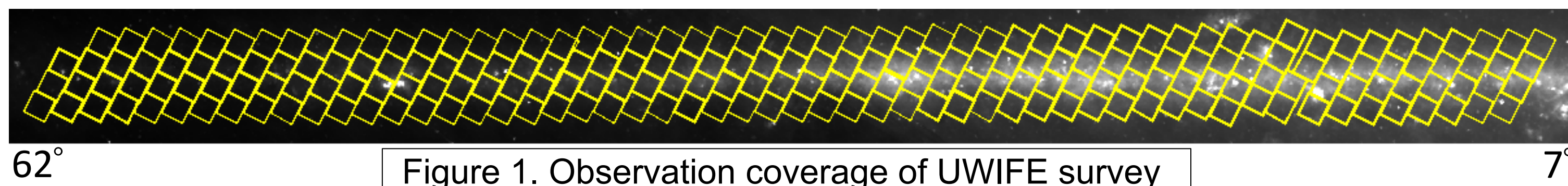


Figure 1. Observation coverage of UWIFE survey

Extended Ionic Fe Object (IFO) catalog (Kim et al. in preparation)

- Identify all diffuse IFO in the survey area using continuum-subtracted emission line image.
- ~ 300 diffuse IFOs are identified.
- IFO J183740.829-061452.41
 - A shell-like IFO located near HII region G25.8+0.2.
- [Fe II] flux $\sim 2.49 \times 10^{-16} \text{ W/m}^2$
- Falls in one of the faint SNR in [Fe II] (Lee, in prep).

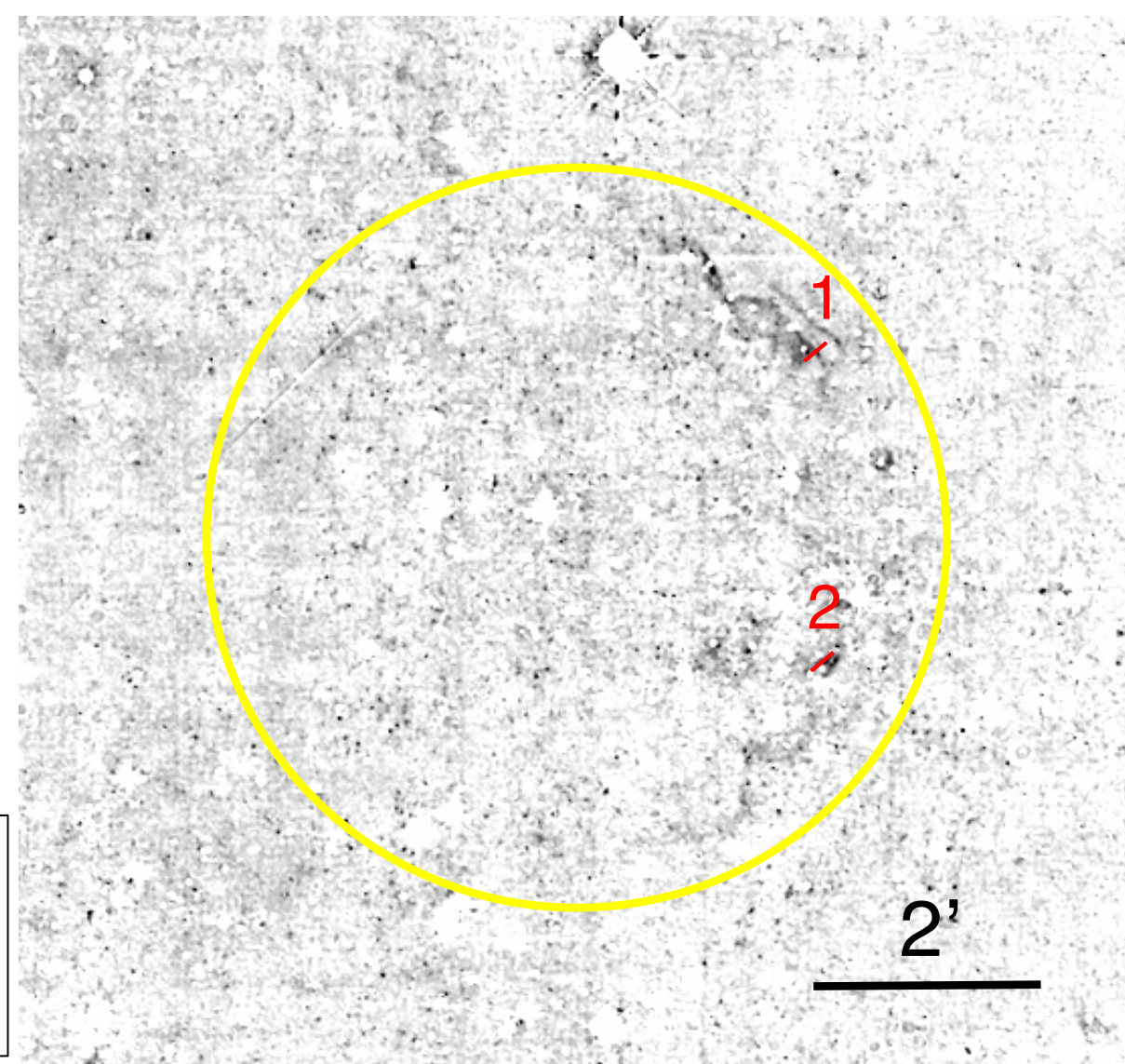


Figure 2. Continuum-subtracted [Fe II] image of J183740. Black : Emission
Yellow : Approximate position and size of IFO
Red : Slit position of spectroscopic follow-up (IGRINS)

Multiwavelength view of $G \sim 26^\circ$ region

Radio structure

1. very faint, large scale radio shell

$\sim 20'$, ~ 36 pc with $d = 6.5$ kpc

2. bright, small radio arc coincide with [Fe II]

$\sim 6'$, 11 pc, known as HII region G25.8+0.2, which makes the spectral measurement of the faint ring(1) difficult.

Firstly recognized in Altenhoff's work(1970) with spectral index of $\alpha = -0.1$.

Radio recombination line was observed with distance of 6.5 ± 0.3 kpc (Russeil+2003).

X-ray diffuse emission & pulsar

- X-ray counterpart of gamma-ray source 3EG 1837-0606 is detected. (Sakamoto & Kawai 2001)
 - Hard component might be a pulsar wind nebula (PWN), though no pulsar is found.
 - Possible SNR is detected in soft x-ray.
 - Millimeter-wave molecular emission rotational line observation suggests pulsar & molecular cloud system.
- X-ray pulsar AX 1837-0610 is studied in detail. (Lin+2008)
 - Coincident with PWN candidate in the study of Sakamoto & Kawai 2001.
 - Candidate period of pulsar is 0.17 s with characteristic age of 1500 yr.
- Faint radio ring which surrounds diffuse X-ray emission is suggestive of SNR / molecular cloud system. (Alberto et al. 2000)

Infrared structure

- Faint shell which coincides with [Fe II] & molecular cloud is observed.

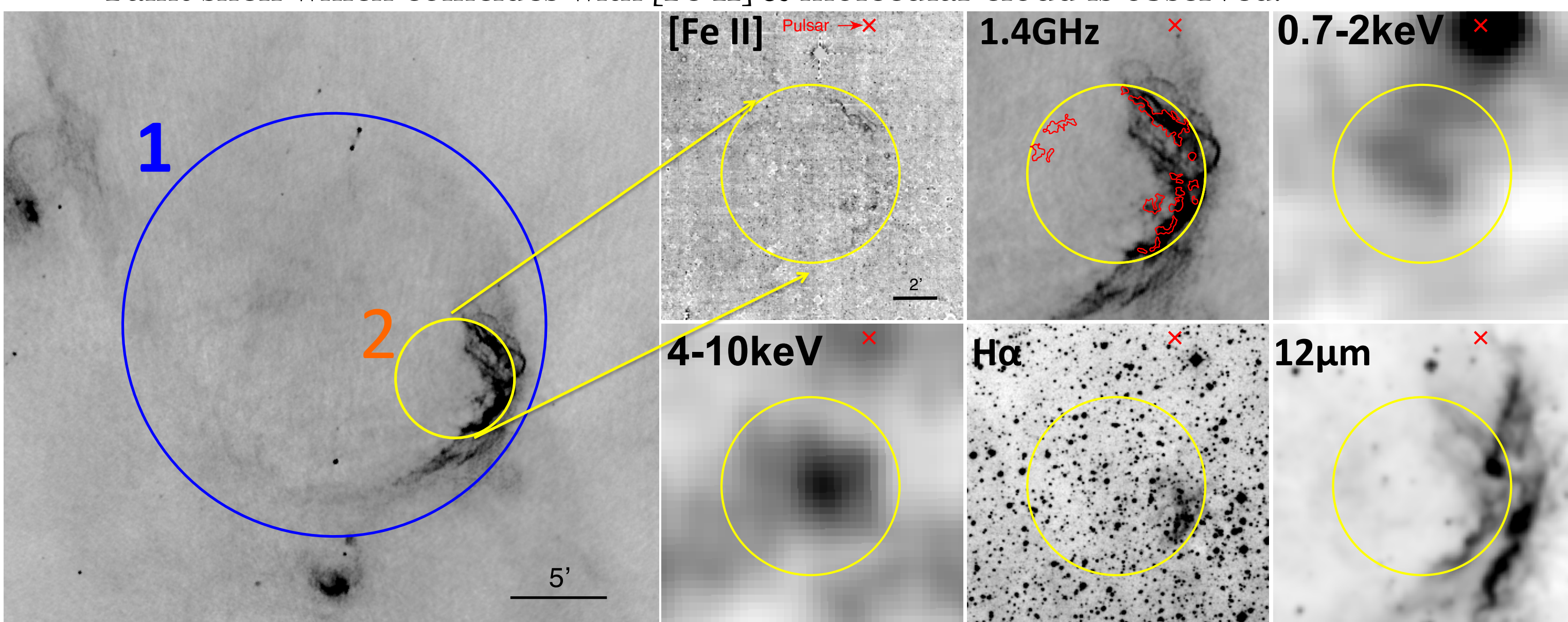


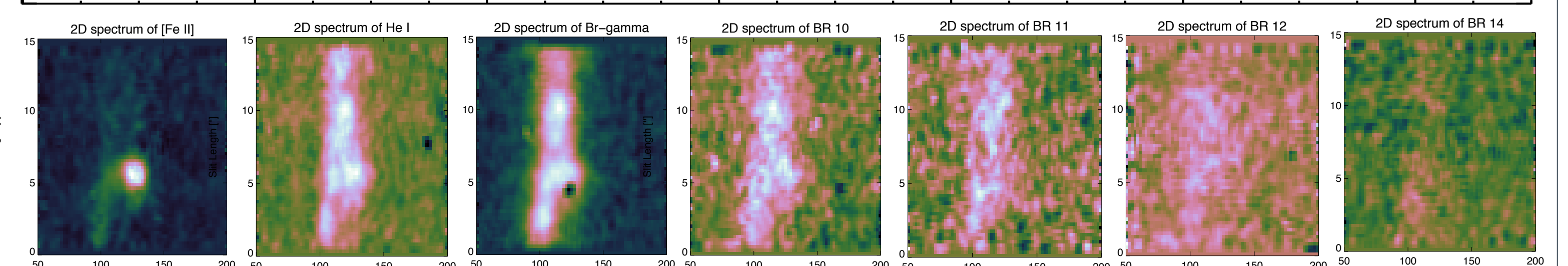
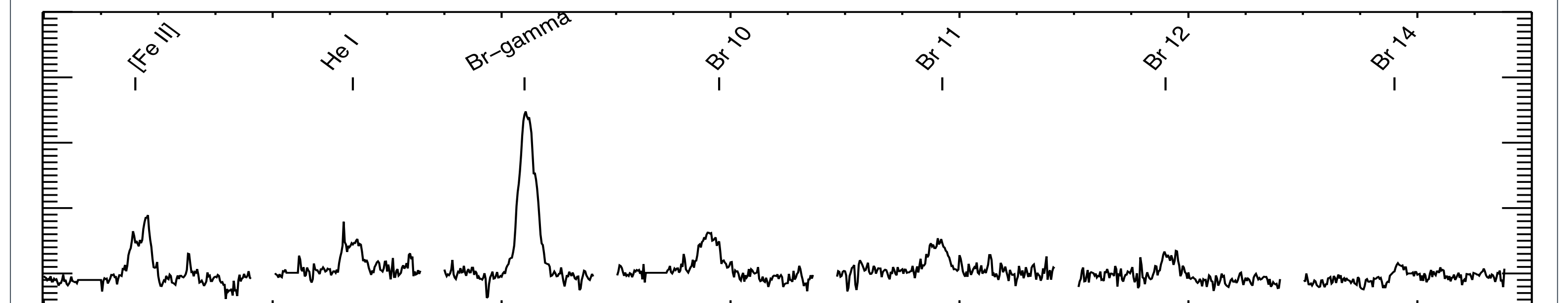
Figure 3. (left) 1.4GHz image of $G \sim 26^\circ$ region, (right, from left to right) UWIFE [Fe II], new-GPS 1.4GHz, ASCA 0.7-2keV, 4-10keV, SHS H α , WISE 12 μm . Red contour : [Fe II] structure, Blue : Approximate size and position of radio structure 1., Yellow : Approximate size and position of radio structure 2, Red x : pulsar AX 1837-0610

IGRINS spectroscopic follow-up

IGRINS observation (Immersion Grating Infrared Spectrograph, Yuk+2010)

- IGRINS: cross-dispersed H,K band spectrograph with resolving power $R \sim 40000$ mounted on 2.7m Harlan Smith telescope at McDonald observatory
- Observation : 2015/08/05 on-off mode.
 - 2 slit position with exposure time of 20 min for each slit position.
- [Fe II] 1.644 μm , He I 2.05 μm , Br- γ , Br 10, Br 11, Br 12, Br 14 are detected.

Slit position 1



Slit position 2

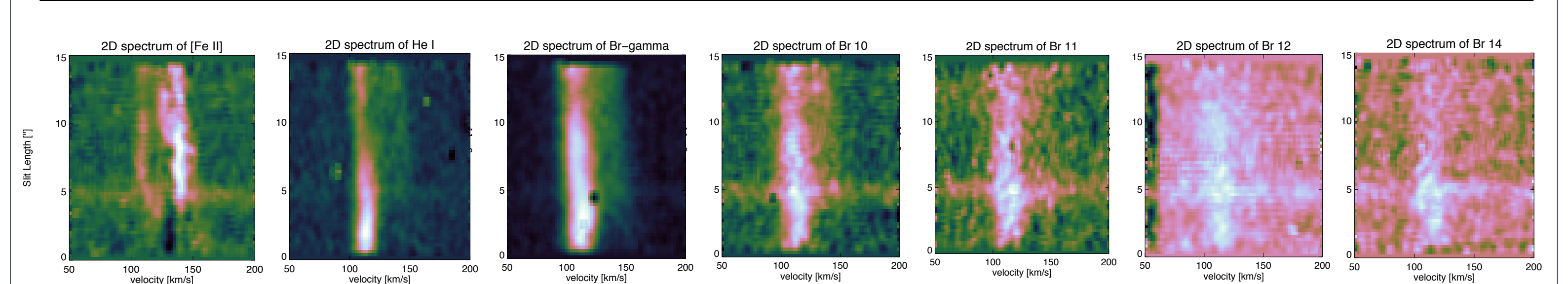
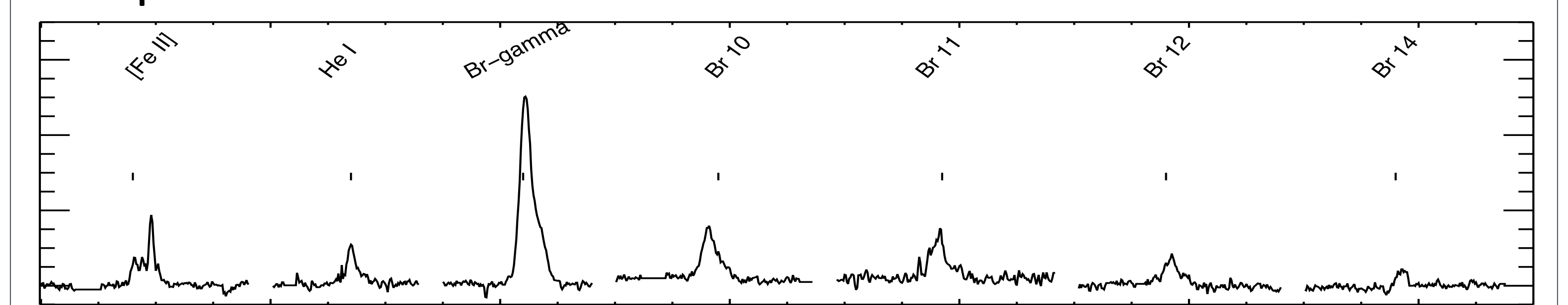


Figure 4. (from left to right) 2D position-velocity diagram of [Fe II], He I, Br-gamma, Br 10, Br 11, Br 12, Br 14. (1st row : slit position 1, 2nd row : slit position 2)

2D spectrum of [Fe II] and Br - γ

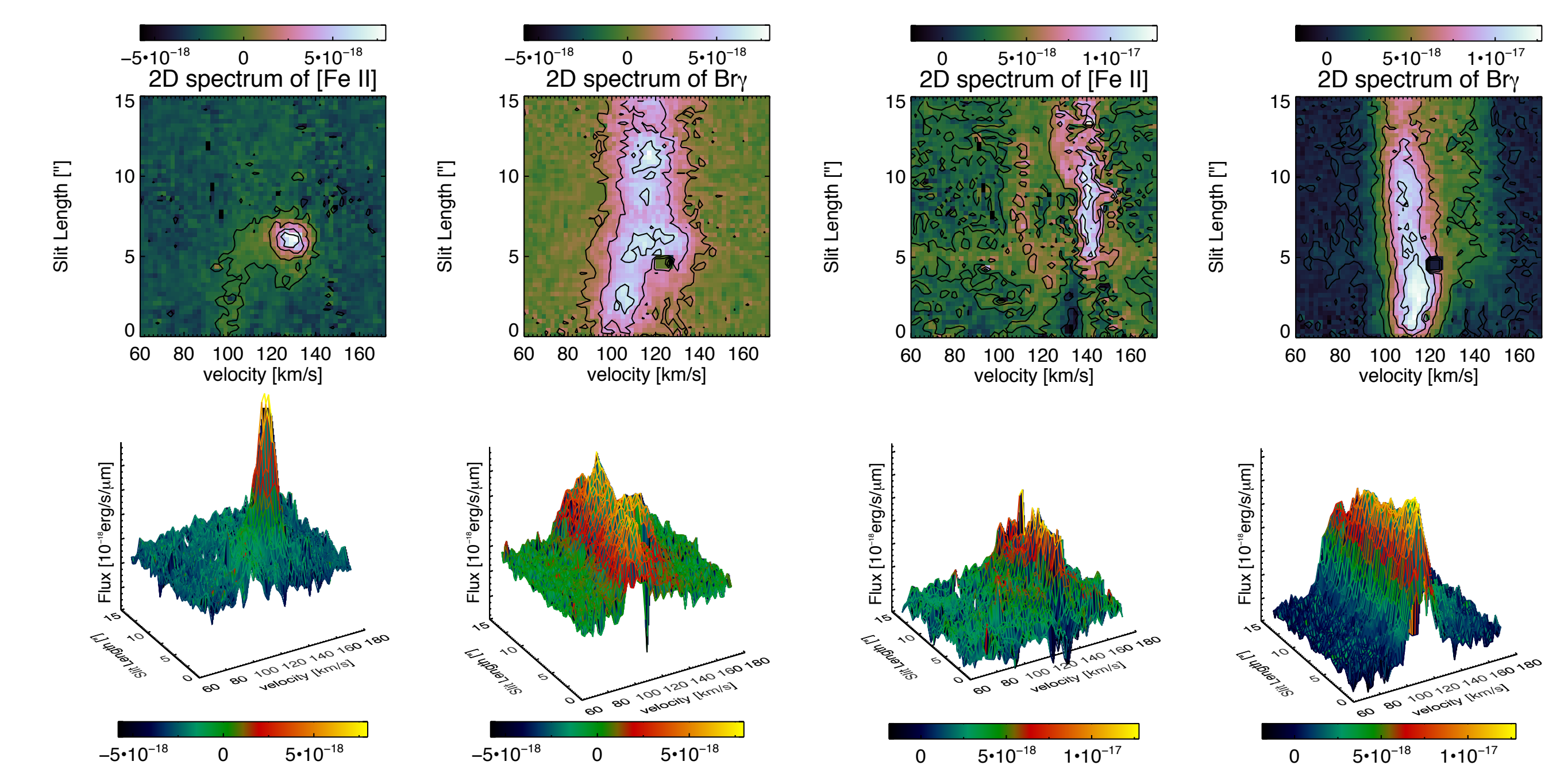


Figure 5. (left) 2D position-velocity diagram of [Fe II] and Br- γ in slit position 1 (right) 2D position-velocity diagram of [Fe II] and Br- γ in slit position 2

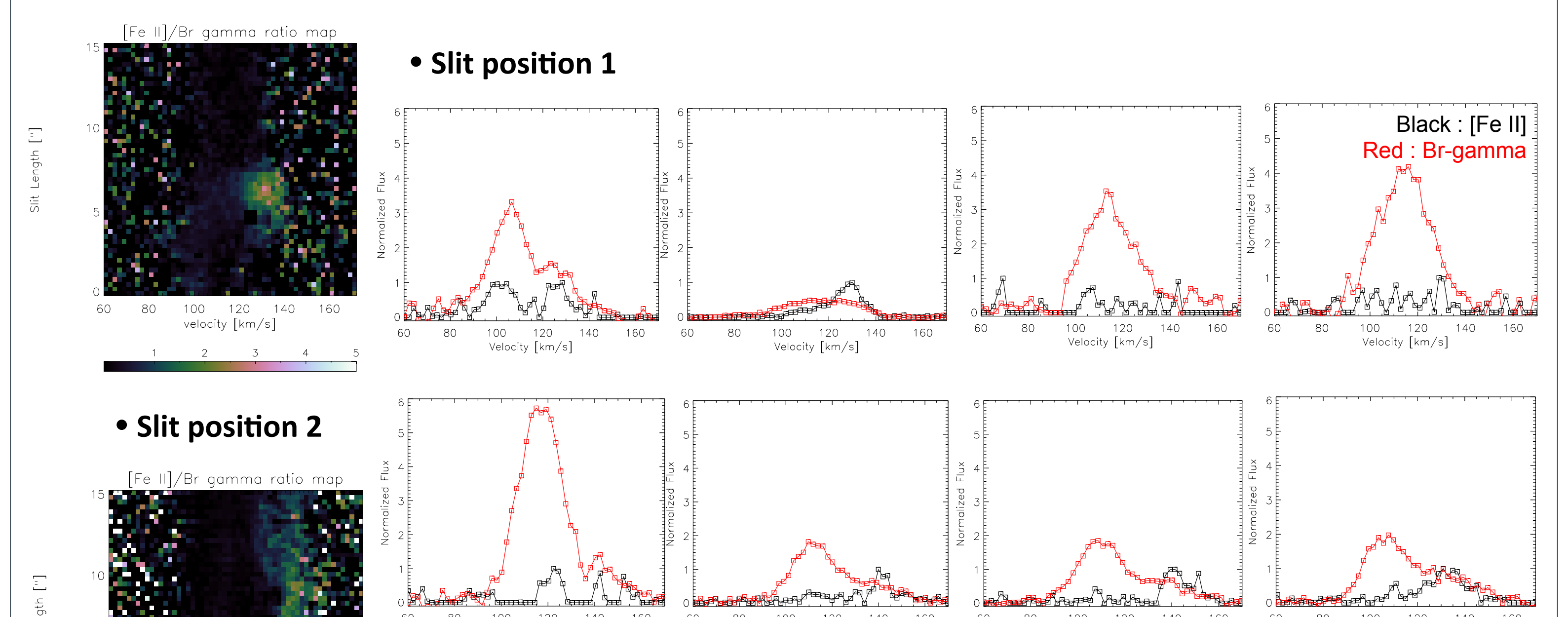
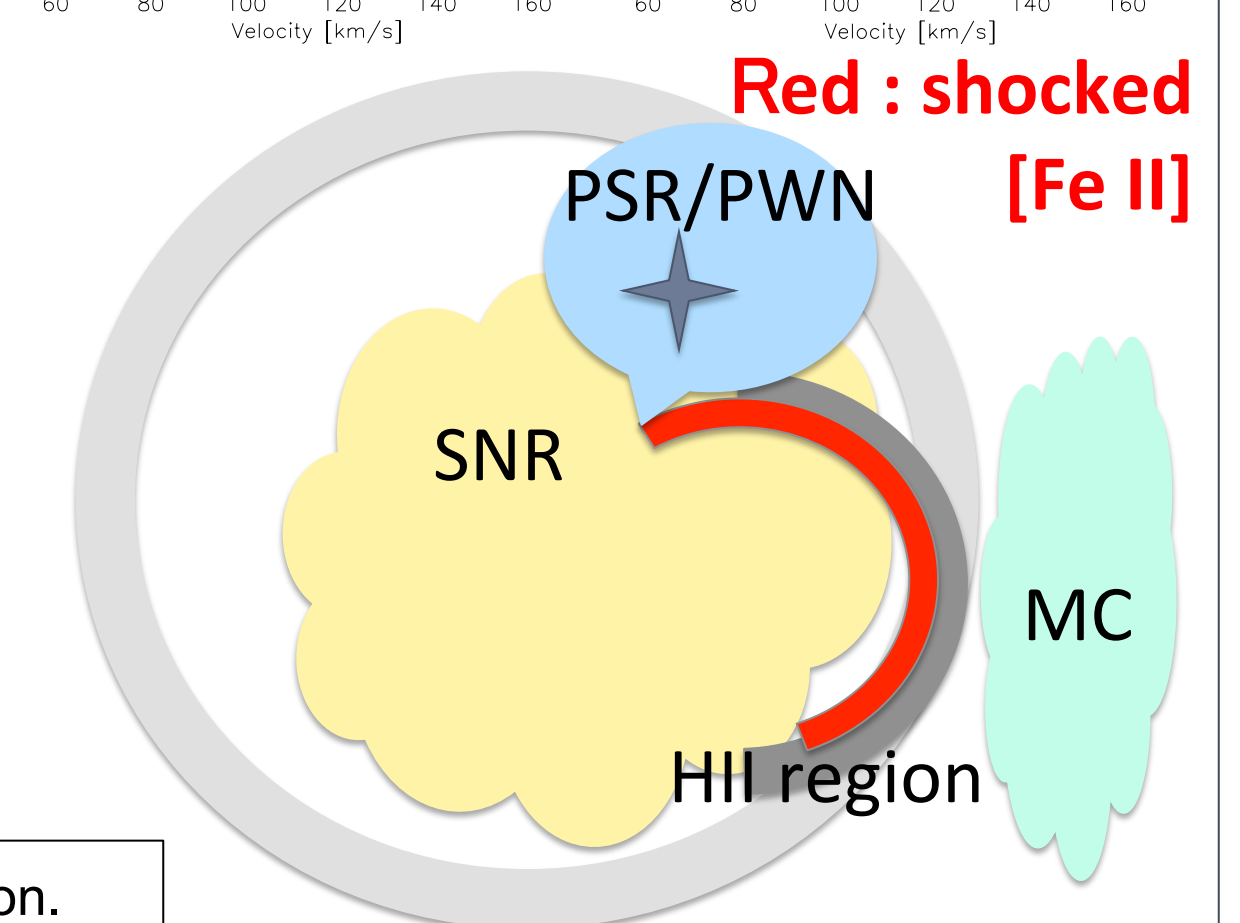


Figure 6. (left) [Fe II] / Br-gamma ratio map of slit position 1, 2. (right) [Fe II] and Br-gamma spectrum of 10, 20, 30, 40th row.

- Shocked region is revealed with [Fe II] / Br- γ ratio up to ~ 2 .

Figure 7. Schematic diagram of $G \sim 26^\circ$ region.



References

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