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Supernova Remnants: Powerful agents of star formation feedback. The case of IC 443

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Abstract: We present the results from our study on the effects of SNRs shocks on molecular clouds. We focused on the multiple gas phases, including ionised, neutral, and molecular gas, and dense molecular phase (n $> 10^4$ cm^{-3}) from which the IMF emerges. We have used optical high–resolution echelle spectra as well as fully–sampled maps of ^{12}CO J=1–0 and ^{13}CO J=1–0. These sets of data along with published available 2MASS, Spitzer and 1.4 GHz continuum maps are used as constraints on our radiative transfer codes in order to deduce the physical conditions for the dense gas in the shock-impacted areas of the molecular clouds.

1 The IC 443 supernova remnant

We have initiated a program (funded under the DeMoGas project*) to investigate the effects of these shocks much more closely, with a focus on the dense gas phase (n $> 10^4$ cm^{-3}) from which the IMF emerges. Given the importance of SNRs in continuously injecting energy in the highly turbulent ISM of ULIRGs (e.g. there are > 50 SNRs in two disks of ∼100 pc diameter in Arp 220), and that Sub–Millimeter Galaxies (SMGs) may be similarly compact starbursts (Swinbank et al. 2010), such a study is indeed timely. We have already acquired optical spectroscopic data from the 2.1-m SPM telescope in Mexico (see Figs. 2 & 3) as well as fully–sampled maps of ^{12}CO J=1–0 and ^{13}CO J=1–0 (Fig. 5). This unique set of data (e.g. optical velocities > 200 km s^{-1} where the molecular emission exists, see Table 1) along with publicly available 2MASS, Spitzer (Fig. 4), and 1.4 GHz continuum maps will be used as constraints on our radiative transfer codes in order to deduce the physical conditions of the dense gas in the shock–impacted areas of the molecular clouds.

Table 1: Optical observations and highest velocities of the SNR's knots where MC emission exists.

No	Target IC443	Exp.t. sec	Filter	slit μm	P.A. deg	V_{HEL}Hα km s^{-1}	V_{HEL}[N II] km s^{-1}	V_{HEL}[O III] km s^{-1}
1	Pos. A	1800	Hα+[N II], [O III]	300	0	-300, +200	-300, +140	-100, +100
2	Pos. B	1800	Hα+[N II]	300	0	-280, +260	-220, +260	-
3	Pos. C	1800	Hα+[N II]	300	0	-80, +40	-80, +40	-
4	Pos. D	1800	Hα+[N II], [O III]	300	315	-80, +40	-80, +40	-
5	Pos. E	1800	Hα+[N II], [O III]	300	315	-80, +120	-80, +80	-40, +40
6	Pos. F	1800	Hα+[N II], [O III]	300	64	-200, +260	-160, +260	-160, +220
7	Pos. G	1800	Hα+[N II]	300	90	-240, +300	-220, +300	-
8	Pos. H	1800	Hα+[N II], [O III]	300	90	-200, +160	-200, +160	-120, +60
9	Pos. T	1800	Hα+[N II], [O III]	300	0	-150, +300	-150, +200	-80, +200

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References

[1] Swinbank et al. 2010, Nature, 464, 733

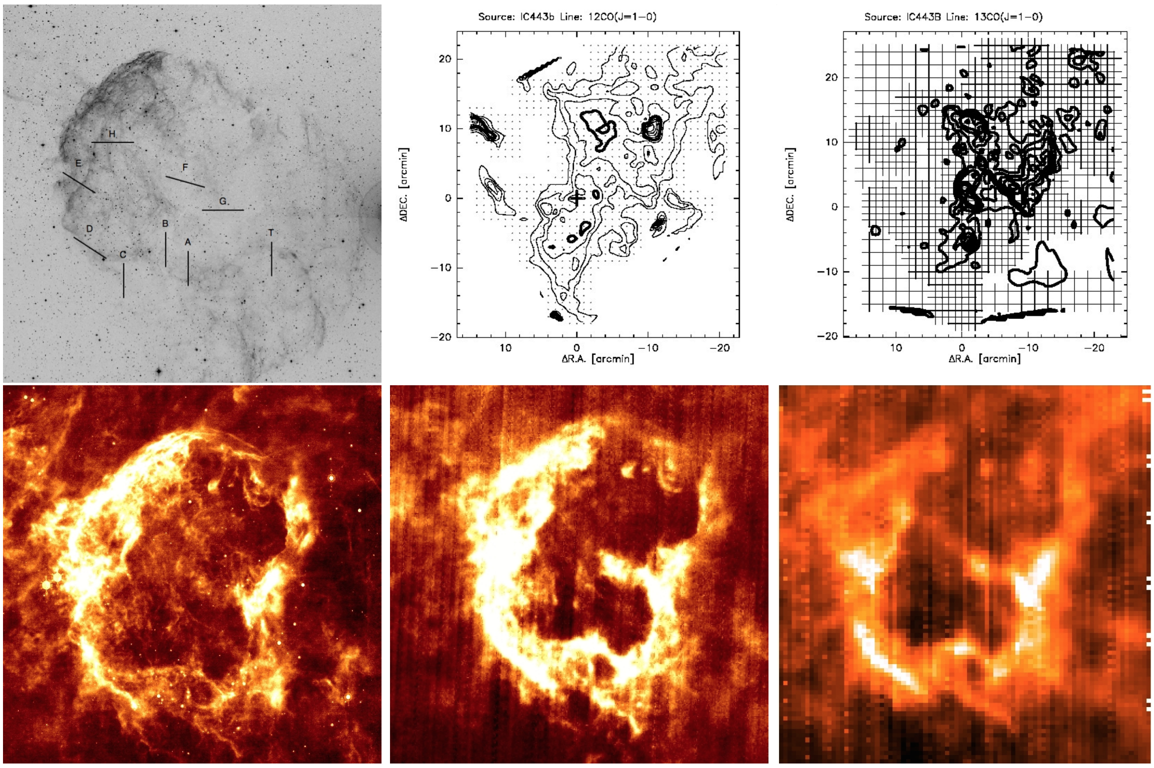

Figure 1: C 443: (Up:) Optical (POSS R) image with the slits of the observed echelle spectra, ^{12}CO & ^{13}CO J=1-0 map of IC 443. (Down:) Spitzer images at 24, 70 & 160μm where the IR emission of IC 443.

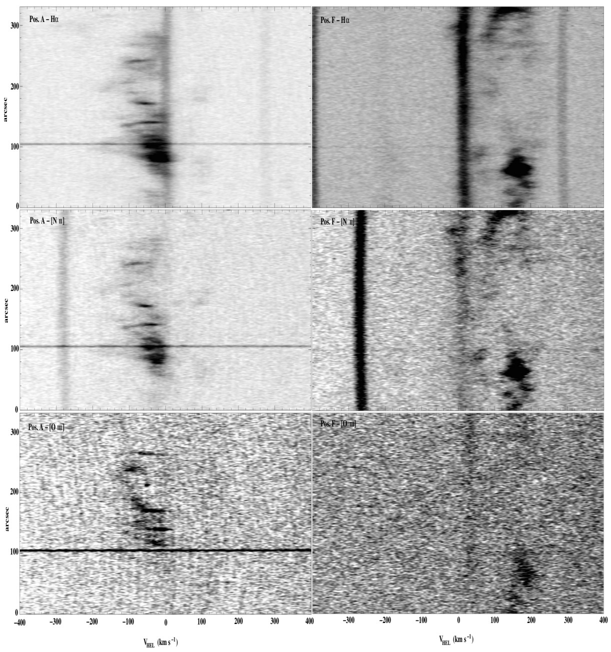

Figure 2: Position-Velocity arrays showing longslit Hα, [N II] and [O III] SPM-MES spectra for IC443 of slit positions A and F, aligned N-S and at P.A.=64deg, respectively, to show the nebular structures. North is to the top. The velocity axis is heliocentric velocity and the y-axis is the slit length in arcsec. The vertical lines are airglow lines and the horizontal are stars.