FIRST GMRT RADIO OBSERVATIONS OF THE SNR CANDIDATE G29.37+0.10

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MOTIVATION

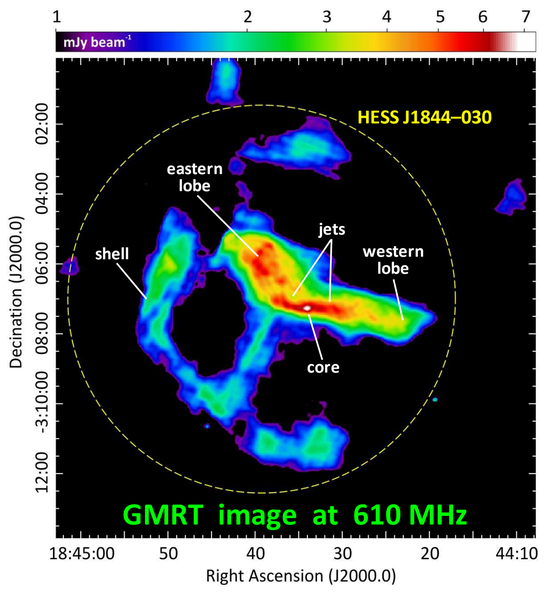
G29.37+0.10 is a radio source proposed to be a new supernova remnant (SNR), although its morphology strongly resembles that of a radio Galaxy. The TeV source HESS J1844–030, whose origin is still uncertain, appears projected on the radio emission. With the aim of elucidating the origin of the peculiar radio source and investigating the nature of the γ-rays, we conducted a multiwavelength study of the G29.37+0.10 region. To make this, we used new observations obtained with the Giant Metrewave Radio Telescope (GMRT), archival data from *XMM-Newton* and *Chandra* observatories, along with data of the molecular and atomic gas distribution toward the G29.37+0.10/HESS J1844-030 system.

OBSERVATIONAL DATA

RADIO CONTINUUM: GMRT 610 MHz data (FWHM = 6''.6 x 5''.3, sensitivity ~ 0.3 mJy beam^{-1}).
X-RAYS: reprocessed *XMM-Newton* (obsID: 0602350101 and 060235201) and *Chandra* (obsID: 11232 and 11801) data in the 1.5 – 8.0 keV energy band.
INFRARED: *Spitzer* observations at 8 and 24 μm (Fazio et al 200, ApJS, 154, 10; Rieke et al ApJS, 154, 25).
MOLECULAR GAS: ^{13}CO (1-0) emission data from the Galactic Ring Survey (GRS, Jackson et al. 2006, ApJS, 163, 145).
ATOMIC GAS: neutral hydrogen (HI) emission data from the VLA Galactic Plane Survey (VGPS, Stil et al 2006, AJ, 132, 1158).

A multiwavelength study of the G29.37+0.10 region

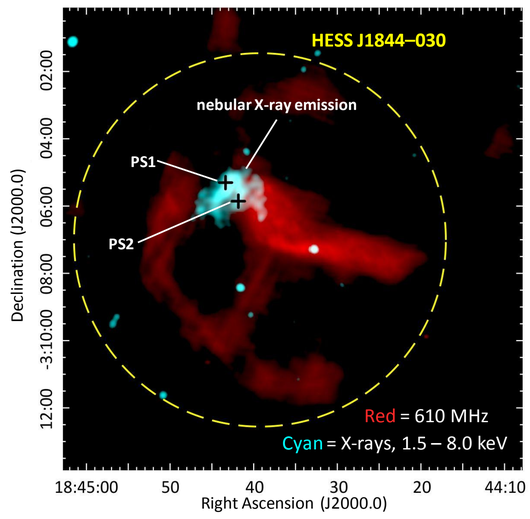
RADIO CONTINUUM EMISSION



- Our new GMRT image at 610 MHz shows that G29.37+0.10 consists of several conspicuous structures:
  - An elongated S-shaped structure ~5' in size.
  - Two opposite jet-like features that appear to emanate from a core and end in two lobes.
  - A clumpy shell partially surrounding the central S-shaped structure.
- The TeV γ-ray source HESS J1844–030 (indicated by the yellow circle in the left figure, Deil et al 2015, ICRC, Aug. 4th 2015) matches position and extension of G29.37+0.10.

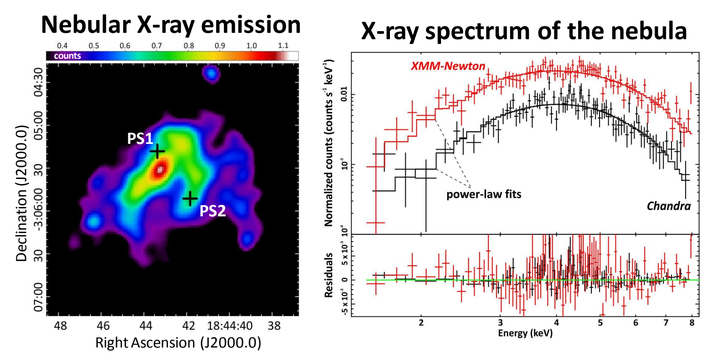
At the *Spitzer* bands centered at 8 and 24 μm we did not find any structure showing a morphological agreement with the radio emission at 610 MHz. This fact supports a non-thermal nature for the radio emission.

X-RAY IMAGING



- The *Chandra* and *XMM-Newton* datasets revealed the presence of two X-ray point sources, PS1 and PS2, inside a nebular emission overlapping the eastern radio lobe of G29.37+0.10.

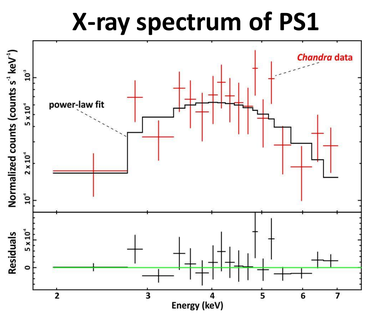
X-RAY SPECTRA



- No clear evidence for thermal line emission.
- Nebular emission well fit by an absorbed power-law model:

  $N_H = (9.6 \pm 0.3) \times 10^{22}$ cm^{-2}

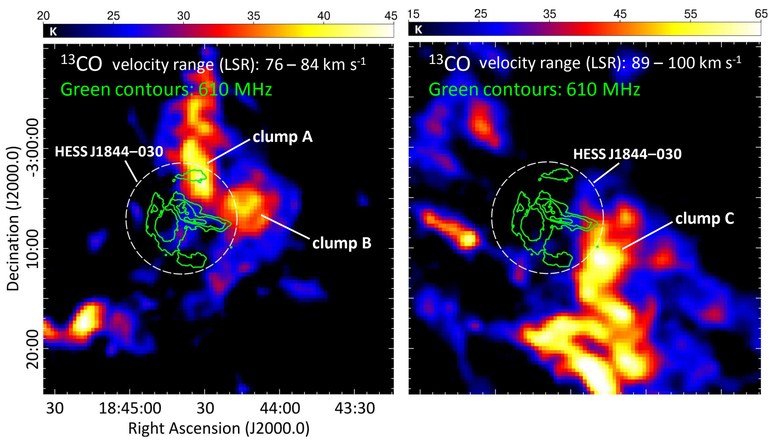
  $\Gamma = 1.76 \pm 0.30$



PS1: a pulsar powering the nebula in G29.37+0.10?

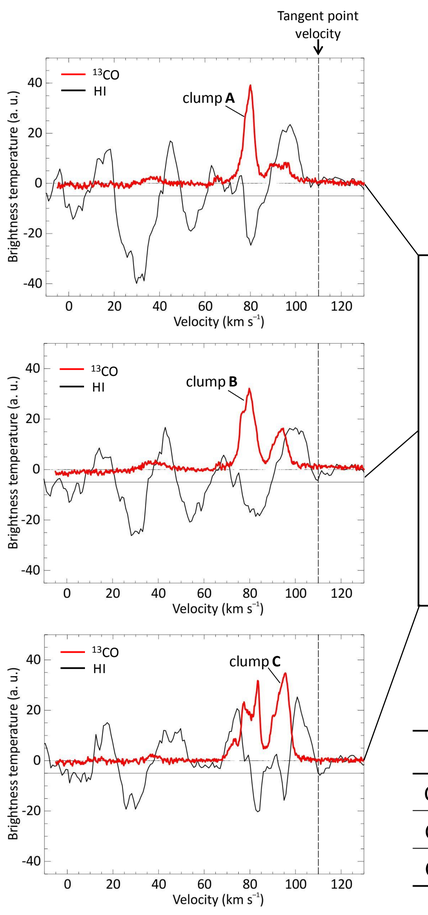
The spectral behavior of the point source PS1 in the 1.5–8.0 keV energy band can be fitted by power-law, as well as a blackbody models.

MOLECULAR MATERIAL TOWARD G29.37+0.10



We detected three ^{13}CO molecular clouds (MCs) in the region of the G29.37+0.10 and HESS J1844–030 sources:

- Clouds A and B at 80 km s^{-1}.
- Cloud C at 94 km s^{-1}.



The ^{13}CO emission spectrum of each MC shows a so-called "shoulder". In a SNR-MC interaction scenario, this spectral asymmetry could be attributed to perturbations in the velocity field caused by the passage of a SNR shock front.

–– Resolving the kinematical distance ambiguity ––

The ^{13}CO emission peaks have associated HI absorption features, attributed to the cold atomic gas embedded in the MC absorbing the emission of the warmer background Galactic HI at the same velocity. A cloud located behind the tangent point will not absorb the foreground HI emission at the same velocity. Thus, the ^{13}CO/HI spectral correlations indicate that the discovered molecular material is at its near kinematical distance.

Physical properties of the newly-discovered clouds, determined by combining the ^{13}CO and HI observations

	Distance (kpc)	Mass ($M_\odot$)	Proton density (cm^{-3})
Cloud A at 80 km s^{-1}	5.0 ± 1.8	2150 ± 650	840 ± 300
Cloud B at 80 km s^{-1}	5.1 ± 1.8	1700 ± 500	910 ± 350
Cloud C at 94 km s^{-1}	5.8 ± 2.0	2100 ± 600	1200 ± 400

The three MCs are dense enough to give account for the TeV flux of HESS J1844–030 (1.0 % of the Crab's) with only a small fraction ~0.1% of a canonical 10^{51} erg SN explosion energy transferred to accelerate protons in the SNR shock.

Signs of Galactic emission

- The incomplete radio shell may be showing a Galactic SNR shock front
- Non-thermal X-rays overlapping the eastern side of the radio emission
- A compact source, PS1, inside the X-ray nebula
- Dense molecular clouds with morphological and kinematical signs of interaction with the radio shell

Signs of extragalactic emission

- The S-shaped morphology strongly resembling that of a radio Galaxy

A PROPOSED SCENARIO

Disentangling the G29.37+0.10 source: its radio emission due to a line-of-sight coincidence of a new Galactic SNR–PWN system with a background radio Galaxy. In this interpretation, the SNR is traced by the radio shell along with the overlapping emission from the eastern radio lobe. The X-rays arise from a PWN, probably powered by the compact source PS1. The S-shaped feature, including the core, the jet-like features, and the lobes, are part of a radio Galaxy.

Origin of the TeV γ-rays: in a SNR-MC interaction scenario, the flux of HESS J1844–030 can be explained by a hadronic process. This idea does not exclude possible leptonic contributions from the interaction of the putative pulsar with its surroundings. However, on the basis of the current observational data, an extragalactic origin cannot be ruled out.

OUTLOOK

- Additional X-ray pointings needed to study whole of radio emission.
- The detection of pulsated emission from the putative pulsar PS1 will shed light on the proposed Galactic nature of G29.37+0.10. Time-series analysis of GMRT observations at 1280 MHz towards PS1 is currently in progress.