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A POSSIBLE INTERACTION BETWEEN SUPERNOVA REMNANT G42.8+0.6 AND A MOLECULAR CLOUD

S. STANIMIROVIĆ[1], L. CHOMIUK[2], C. J. SALTER[3], D. UROŠEVIĆ[4], R. BHAT[5] and D. R. LORIMER[6]

[1]*Department of Astronomy, University of California at Berkeley, 601 Campbell Hall, Berkeley, CA 94720*
E–mail sstanimi@astro.berkeley.edu

[2]*Astronomy Department, Wesleyan University, Middletown, CT 06459*
E–mail lchomiuk@wesleyan.edu

[3]*Arecibo Observatory, NAIC/Cornell University, HC 3 Box 53995, Arecibo, PR 00612*
E–mail csalter@naic.edu

[4]*Astronomy Department, University of Belgrade, Studentski Trg 16, 11000 Belgrade, Serbia and Montenegro*
E–mail dejanu@poincare.matf.bg.ac.yu

[5]*Haystack Observatory/MIT, Off Route 40 Groton Rd, Westford, MA 01886-1299*
E–mail rbhat@haystack.mit.edu

[6]*University of Manchester, Jodrell Bank Observatory, Macclesfield, Cheshire, SK11 9DL, UK*
E–mail drl@jb.man.ac.uk

Abstract. We have recently undertaken detailed observations of supernova remnant (SNR) G42.8+0.6 with the Arecibo 305-m radio telescope to investigate its possible association with two unusual neutron stars. We have found a patch of OH absorption just below its rim which originates from a molecular cloud that is, most likely, interacting with the SNR. This cloud has curious OH line ratios, far from what is expected for thermal equilibrium. The OH absorption allows us to estimate a lower distance for the SNR of (11 ± 3) kpc. While G42.8+0.6 lies beyond SGR 1900+14 it could be associated with PSR J1907+0918.

1. INTRODUCTION

The supernova remnant (SNR) G42.8+0.6 appears to be a typical, faint, shell-type SNR, with an angular size of $\sim$24 arcmin (Green 2000). However, two unusual neutron stars are projected just outside of it. One is the soft-gamma repeater, SGR 1900+14 (Hurley et al. 1998). The other, PSR J1907+0918, is a young (characteristic age $\sim$38 kyr) 226-ms radio pulsar (Lorimer & Xilouris 2000). It is possible that the SNR marks the birth-place of either, or both, of these neutron stars. However, distances to all three objects are rather uncertain. In particular, all previous estimates for

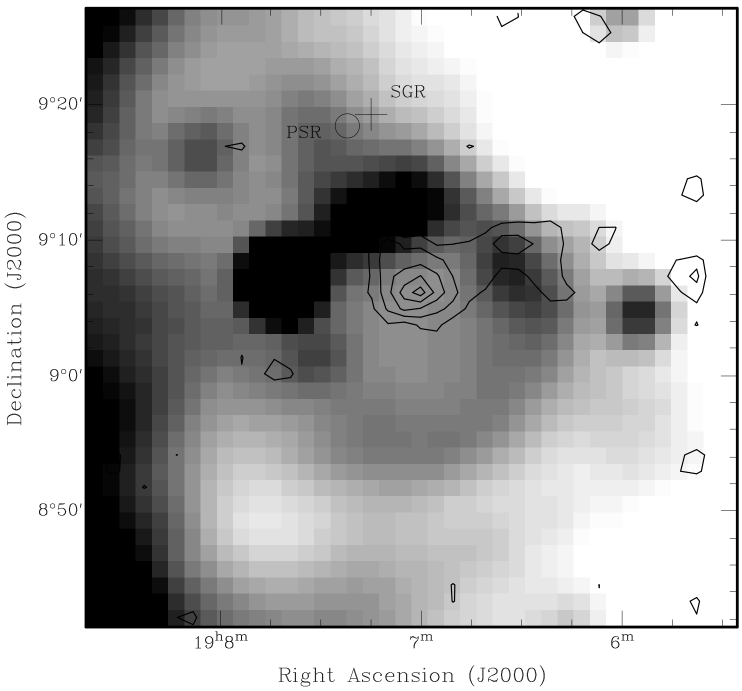

Figure 1: A radio continuum image of G42.8+0.6 at 1180 MHz overlaid with contours of the OH spectral-line intensity integrated over velocity range of 12 − 24 km s^{-1}. The gray scale image shows a well-defined shell of G42.8+0.6. The contours show the extent of the OH absorption patch. Positions of SGR 1900+14 and PSR J1907+0918 are shown with a cross and a circle, respectively.

distance of the SNR were based on the $\Sigma - D$ relation. The main motivation for this project is to investigate possible connections between the three objects, and to study morphological and polarization properties of the SNR.

2. OBSERVATIONS

The observations were undertaken with the 305-m Arecibo telescope[1] in May 2002 and consisted of several parts. Search for radio pulsations from SGR 1900+14 was performed, while polarimetric and HI absorption observations were undertaken on J1907+0918. Full-Stokes continuum mapping at a range of frequencies from 430 MHz to ∼3 GHz was performed to investigate morphological and polarization properties of G42.8+0.6, as well as to determine its spectral index. HI and OH spectral-line mapping was also undertaken to search for absorption by clouds situated directly in front of the remnant.

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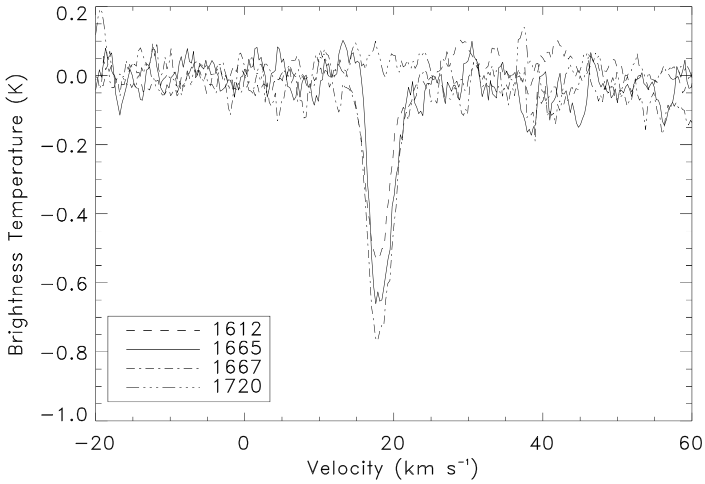

Figure 2: OH absorption spectra at 1612 (dashed line), 1665 (solid line), 1667 (dot-dashed line) and 1720 MHz (dot-dot-dashed line) toward the center of the patch at RA 19^{h} 07^{m} 00^{s}, Dec 09° $06'$ $00''$.

3. PRELIMINARY RESULTS

Fig. 1 shows a radio continuum image of the SNR at 1180 MHz. We confirm that the SNR has a well-defined shell showing pronounced edge brightening. In both 1665 and 1667 MHz OH mainlines we have found a small-diameter absorption patch, at radial velocity of 20 km s^{-1}, projected against the interior of the SNR. The OH spectral-line data are overlaid on the continuum image in Fig. 1. Furthermore, the HI distribution over the same velocity range shows an edge-brightened emission feature that matches the structure of the SNR. The OH absorption patch and the HI ring most likely originate from a molecular cloud that is interacting with the SNR.

3. 1. SNR DISTANCE

If the OH absorption patch and the HI ring are associated with the SNR, we can estimate the SNR's kinematic distance to (11 ± 3) kpc, using the model for Galactic rotation by Fich, Blitz & Stark (1989), and adopting the farther distance solution for this particular line-of-sight. This agrees well with the distance of 13 kpc imposed from the $\Sigma - D$ relation (Urošević 2003). This implies the SNR size of about 80 pc. This also means that the SNR is beyond the SGR 1900+14, which is estimated to be at 6 kpc (Hurley et al. 1998). The most recent estimate for the distance of PSR J1907+0918 is (8 ± 1) kpc, using the electron density model by Cordes & Lazio (2002). PSR J1907+0918 and G42.8+0.6 could be related! Their ages are reasonably similar (Lorimer & Xilouris 2000), and a pulsar transverse velocity of 4000 km s^{-1} could have carried it to its current position, 20 arcmin from the center of the SNR.

3. 2. THE OH PATCH

The OH absorption patch exhibits curious 1612:1665:1667:1720 MHz line ratios, see Fig. 2, far from the ratios 1:5:9:1 expected for molecular gas in thermal equilibrium. The 1612- and 1665- MHz lines are both significantly stronger relative to the 1667-MHz line than they would be for thermal equilibrium. No line at all was detected at 1720 MHz. The OH Sum Rule (Rogers & Barrett 1967) suggests that the line ratio discrepancy can be explained in terms of high optical depth. In addition, the OH excitation temperature in this cloud must be very low, less than a few K. We are undertaking follow up observations with the BIMA and the VLA to better understand the chemistry of this region.

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