A new radio look of the pulsar wind nebula 3C 58

Castelletti Gabriela
Giacani Elsa

Institute of Astronomy and Space Physics
Buenos Aires, Argentina

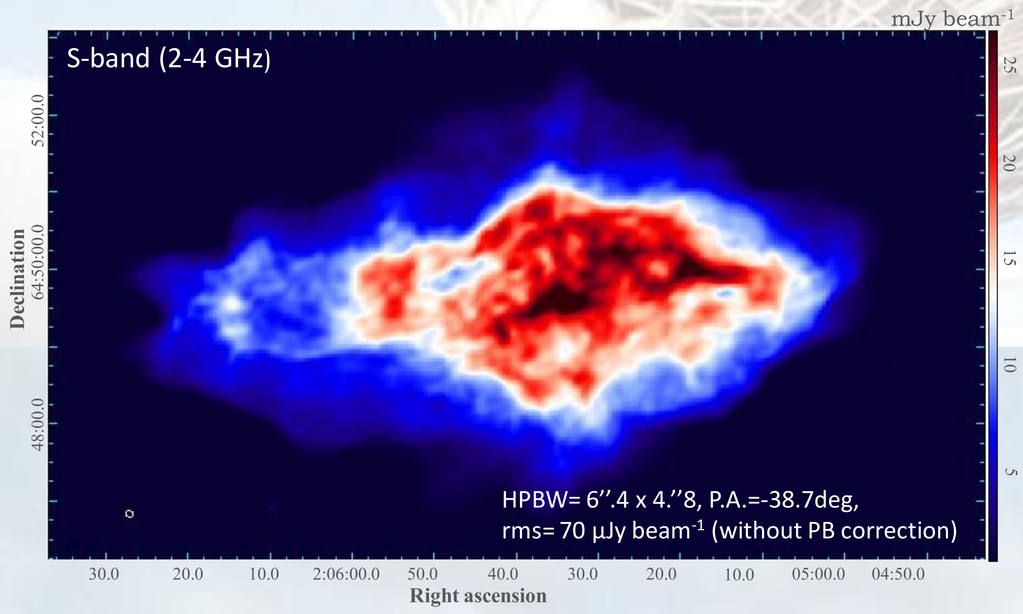
BACKGROUND

3C58 (G130.7+3.1), is without doubt an archetypical example of a pulsar wind nebula. It is powered by the pulsar **PSR J0205+6449**, which provides with 2.7×10^{37} erg s^{-1} to the PWN, a factor almost 20 times smaller than the Crab's pulsar. The kinematic distance to 3C58 is 2 kpc, derived from HI data (Kothes 2013, AA, 560).

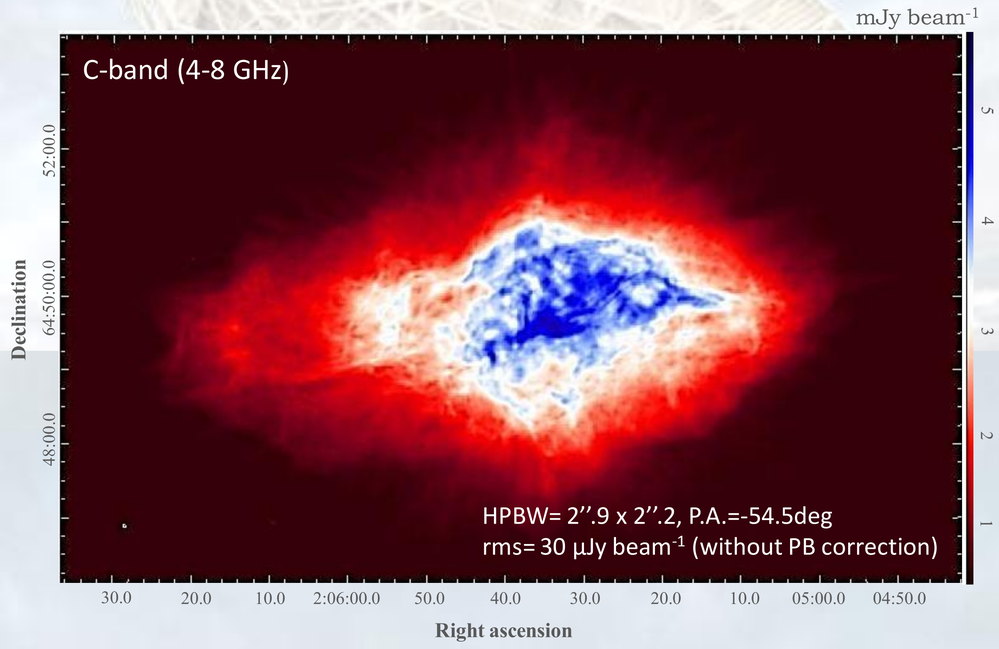
THE NEW DATA

We present here new full-synthesis imaging of intensity and polarization observations of 3C58 made on 2017 June with the wide-band S (2-4 GHz) and C (4-8 GHz) receivers of the Karl G. Jansky Very Large Array (JVLA) in its C and D configurations. The observations in the S frequency band consisted in a single pointing while in the C band a mosaicking mode by combining 10 different pointings was used to cover the full extension of 3C58. The Common Astronomy Software Applications (CASA) package was used for all of the reduction procedures. A wide-field imaging technique combined with multi-scale and multi-frequency deconvolution algorithms were adopted to construct Stokes I, Q, and U images over the full observed bandwidths.

3C58 IN TOTAL INTENSITY

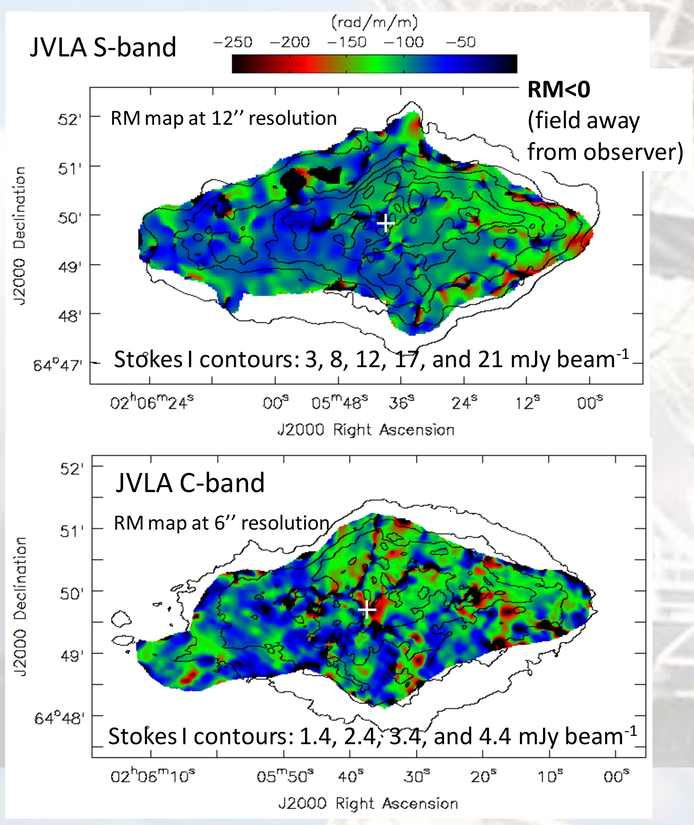


These images provide in the wide range of frequencies 2-8 GHz the highest sensitivity radio data of the 3C58 nebula known to date. The great variety of radio-features with spatial scales from ~10''-8' and ~6''-4' in S- and C-band, respectively, are well sampled.

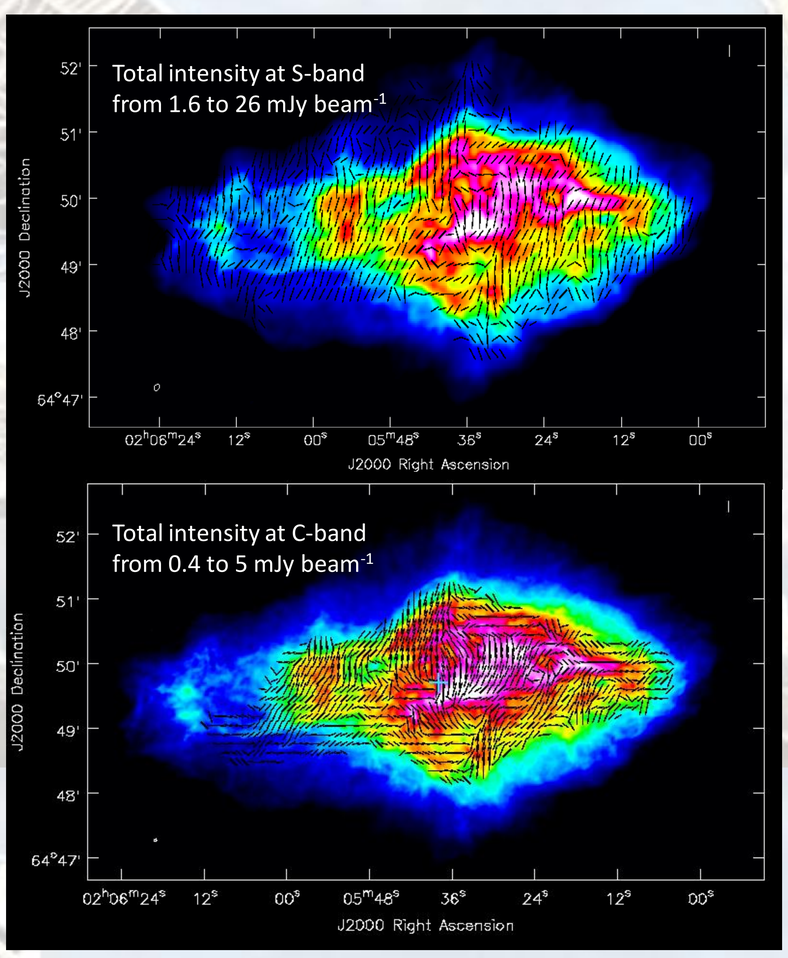


ROTATION MEASURE AND THE MAGNETIC FIELD DISTRIBUTION

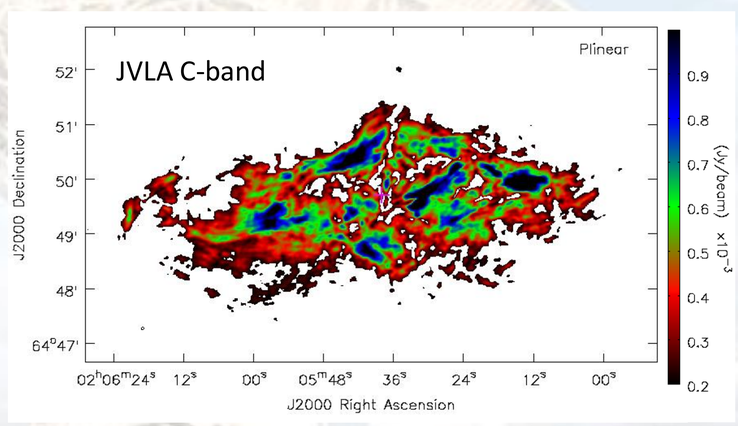
The new wideband JVLA observations allow for accurate rotation measures across the source. This information was used to determine the magnetic field (B) configuration in the nebula. The S-band(C-band) data consist of 16(31) spectral windows each 128 MHz wide with 64 frequency channels. Using the calibrated data, we formed a series of Stokes Q and U images for each frequency band separately. The visibility data were tapered in the imaging process. The output products, concatenated along the spectral axis, were then fitted using the CASA rmfit task to determine the RM distribution and the intrinsic polarization position angle in 3C58 (Leahy+1986, AA, 156). The algorithm that this task uses resolves the unknown number of half rotations of the polarization angle between the source and observer.



Faraday RM structure (corrected for the Galactic RM distribution) of 3C58 computed from JVLA S-band (*top*) and C-band (*bottom).* data. Uncertainty in RM is less than 20 rad m^{-2} in regions with $|RM| > 100$ rad m^{-2} and about 15-25 rad m^{-2} in the lower $|RM|$ components. Clearly, the RM is not constant across 3C58. A tendency for less negative RM values in the eastern part of 3C58 can be seen. There is no an obvious correlation between the RM distribution and total intensity features.



Magnetic field (B) configuration in 3C58 calculated using our RM maps (*left*). All points with errors >25deg were blanked. Both maps reveal an impressive correlation between the filamentary loops in the highest brightness region of 3C58 near the pulsar and the structure of B. In the outer regions of the nebula the orientation in components B is primarily in a W-E direction.



Map of the polarized intensity of the emission from 3C58 at a representative frequency of 6 GHz (a similar distribution, not shown here, is observed in S-band). There are prominent patches (size~0.01deg = 0.35pc at d_{3C58}~2kpc) of high polarized emission (~20-35%) along the edge of the nebula. The polarized emission is uncorrelated with brightness distribution (e.g. high relative fractional polarization corresponds to both high and low total intensity features in the brightest part of the nebula).

FUTURE WORK

- Investigate depolarizing mechanisms operating in the 2-8 GHz range.
- Extent our analysis using the technique of RM synthesis to measure the Faraday spectrum separating contributions from multiple interfering components.

CONTACT
gcastell@iafe.uba.ar
egiacani@iafe.uba.ar