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MeerKAT uncovers the physics of an Odd Radio Circle

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ORC: ASKAP, GMRT, MeerKAT

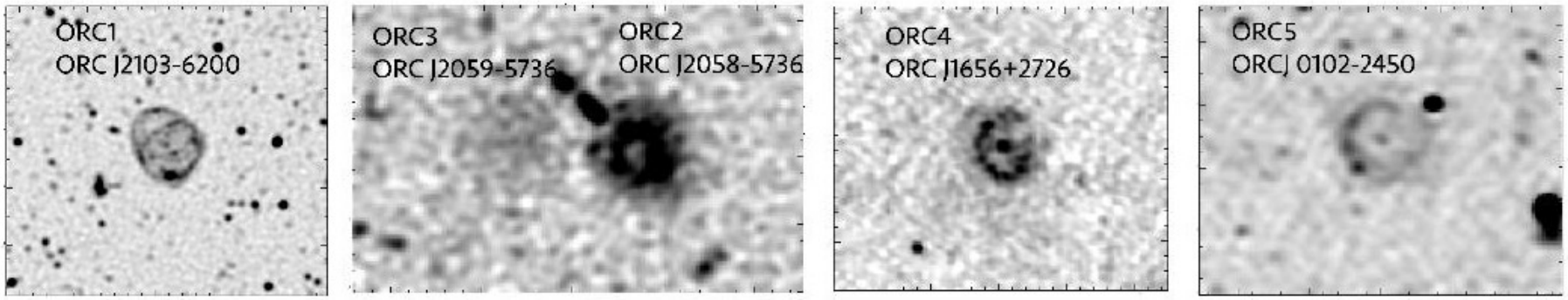


Figure 18. Radio images of the five published ORCs, each at a similar scale. The image of ORC1 is from MeerKAT observations described in this paper, ORC2 and 3 are from ASKAP observations (Norris et al. 2021b), ORC4 is from GMRT data (Norris et al. 2021b), and ORC5 is from ASKAP data (Koribalski et al. 2021).

ORC1: MeerKAT

- 64 антенны, 13.5 м каждая, база 8 км
- Пространственное разрешение 6’’
- Перестраиваемая полоса: кроме изображения, еще и спектр
- Поляризация

ORC1: лучше разрешение – больше деталей в морфологии

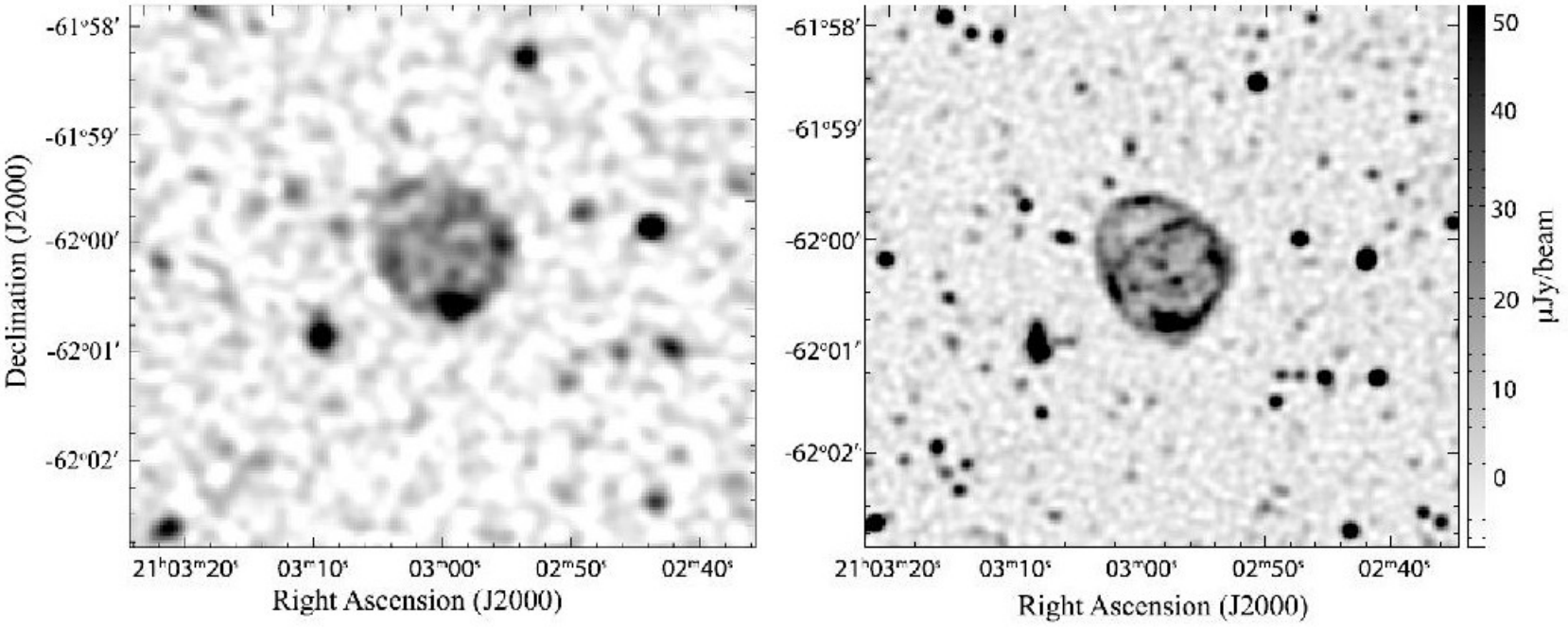


Figure 1. (Left) The ASKAP image of ORC1, adapted from Norris et al. (2021b) at 944 MHz. The resolution is 11 arcsec, and the rms sensitivity is 25 μJy/beam. (Right) The new Meerkat image of ORC1 at 1284 MHz. The resolution is 6 arcsec, and the rms sensitivity is 2.4 μJy/beam. A FITS file of these images is available in the online supplementary material.

Две радиогалактики проецируются на ORC1

Table 1. Properties of the optical/IR sources associated with the ORCs.

Source Name	ID	radio flux density [mJy]	Observing Frequency (MHz)	Fractional radio luminosity	1.4 GHz luminosity W/Hz	SFR $M_\odot$/yr	DES/SDSS g [AB mag]	r	i	z	WISE W1 [Vega mag]	W2	W3	z_{phot}
WISEA J210258.15–620014.4	ORC1C	0.091	1284	0.027	7.3×10^{22}	40.2	22.04	20.10	19.23	18.79	15.07	14.98	>12.94	0.55
WISEA J210257.88–620046.3	ORC1S	0.74	1284	0.222	5.9×10^{23}	326.6	19.73	18.95	18.55	18.35	15.47	15.06	11.20	0.23
WISEA J155524.65+272633.7	ORC4C	1.43	325	0.026	3.7×10^{23}	203.5	21.18	19.64	19.00	18.40	15.50	15.31	>13.19	0.46
WISEA J010224.35–245039.6	ORC5C	0.1	944	0.050	1.6×10^{22}	8.8	20.43	18.97	18.48	18.18	15.39	15.19	>12.36	0.27

ORC1C, ORC4C, ORC5C are the central galaxies in their respective ORCs. ORC1S is the galaxy superimposed on the south of the ring in ORC1, which we consider to be unlikely to be physically associated with the ORC because of the very different redshift. Fractional luminosity is the flux density of the galaxy divided by the flux density of the diffuse emission of the ORC. Radio luminosity is calculated at 1.4 GHz to enable comparison with other results, and to calculate SFR (the calculated star formation rate if all the radio emission of the galaxy were due to star formation) using the relation derived by Bell (2003). Redshifts are from Zou et al. (2020).

ORC1=группа галактик?

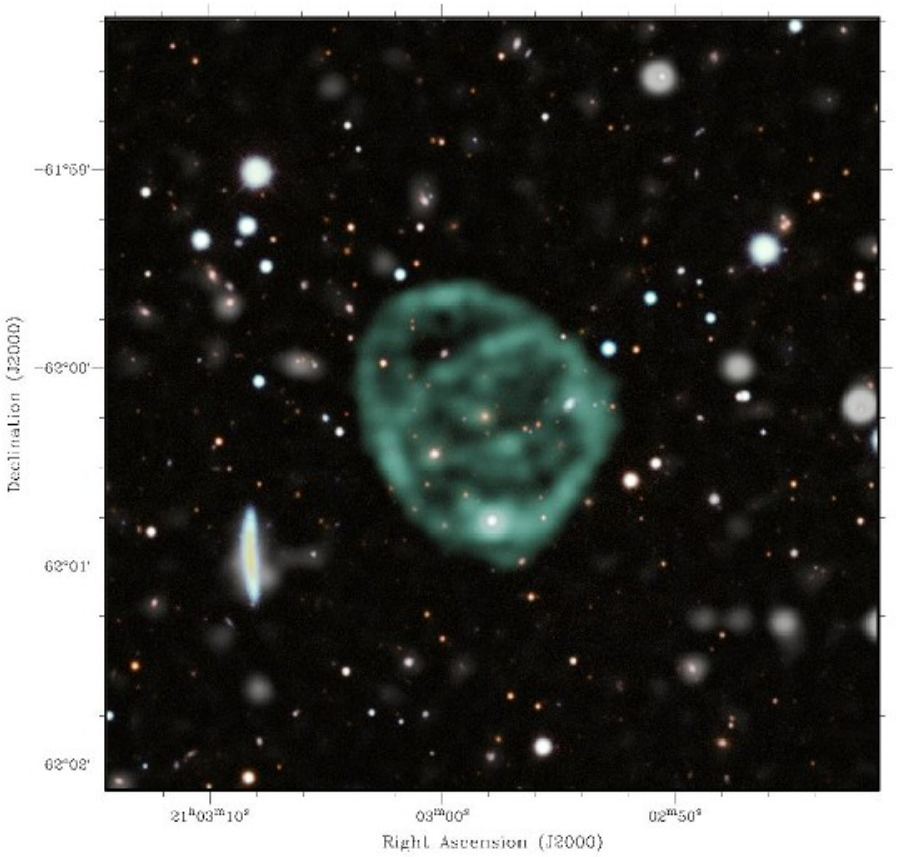


Figure 2. The MeerKAT Stokes-I image of ORC1, superimposed on optical data from the Dark Energy Survey DR1(Abbott et al. 2018), both spanning the same field of view. A square root transfer function was applied to the radio data of the field of view and this greyscale image was then adjusted for contrast. An image of the radio data confined to the ORC region was assigned mint green. This region was blended with the greyscale radio continuum field of view image and the DES optical image of the same field, so that faint radio sources outside the ORC appear as faint grey diffuse patches, often surrounding their host galaxies. The filters used in the DES image were assigned turquoise, magenta, yellow and red, with the result that DES sources mainly appear in this image as white. The layering schema employed is described in English (2017). This figure is optimised to convey the structure of the ORC, and quantitative information should be taken from Figure 1 or from the FITS files in the Supplementary Information.

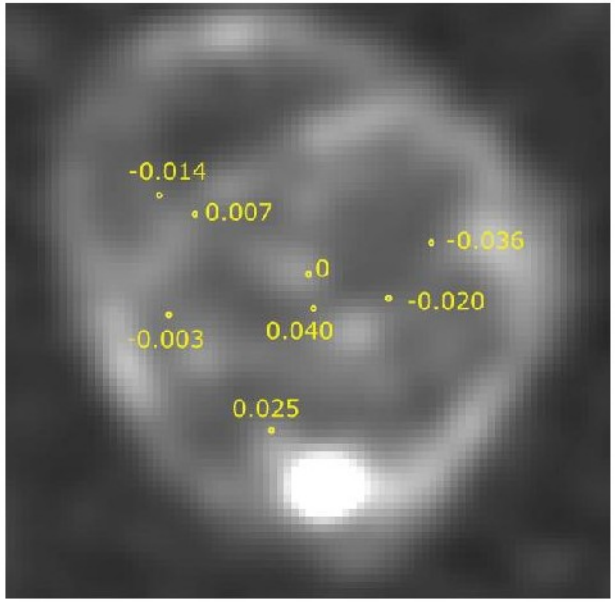


Figure 8. Galaxies with positions and photometric redshifts within the ORC, superimposed on a greyscale representation of the Meerkat continuum image. Each small circle represents one of the eight galaxies in the central overdensity shown in Figure 7. The number next to each is the difference between their redshift and that of ORC1C, all of which agree within 1 standard error.

Спектр и поляризация =синхротрон и магнитное поле

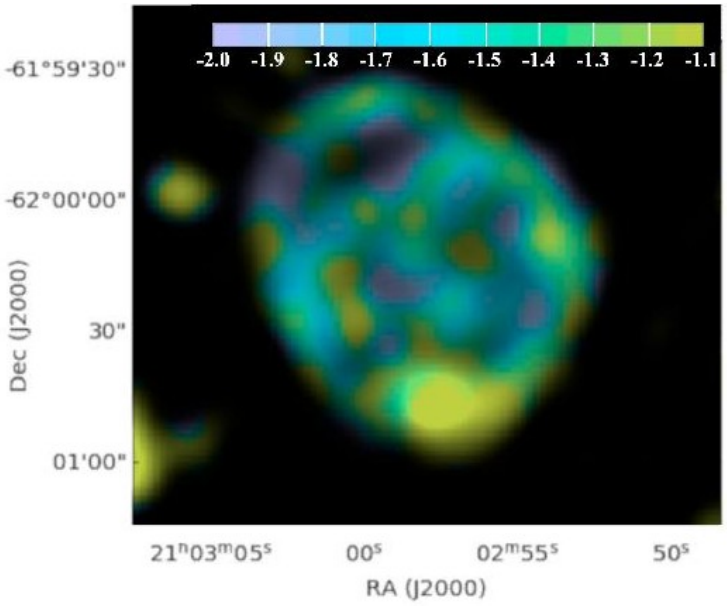


Figure 3. The Meerkat spectral index image of ORC 1. An equiluminant colour table (Richardson et al. 2021) shown in the colour bar, spans the spectral index range of -2.0 < α < -1.1. Outside the spatial region of the ORC, the purple also represents α < -2.0 while the green-yellow represents α > -1.1. The spectral index map has been multiplied by a square root black and white stretch of the total intensity map, which was subsequently adjusted for contrast. We estimate the uncertainty in spectral index to be ~0.1.

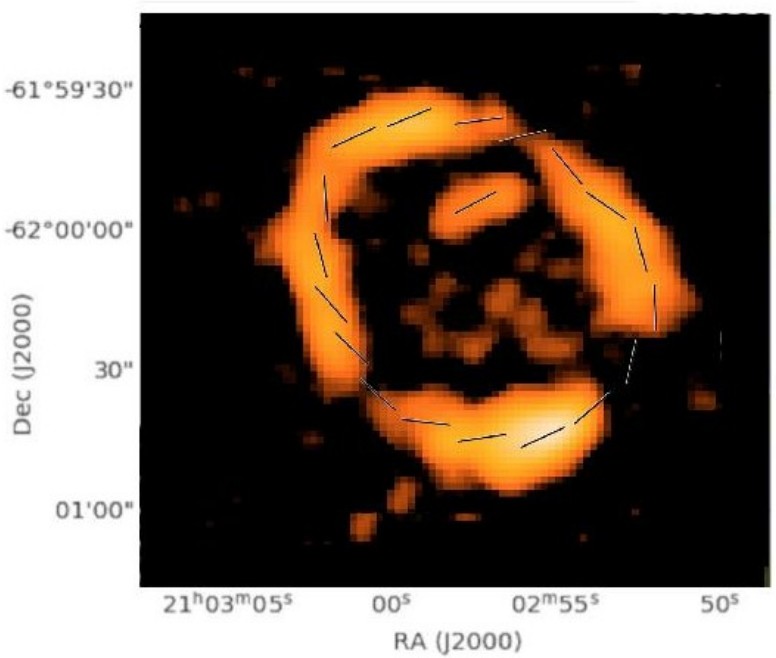


Figure 5. The B vectors of the polarisation of ORC 1, corrected to zero wavelength using the derived rotation measure, overlaid on the total polarisation image, indicating a tangential magnetic field in the ring.

Оптически тонкая сферическая оболочка + ? Модели:

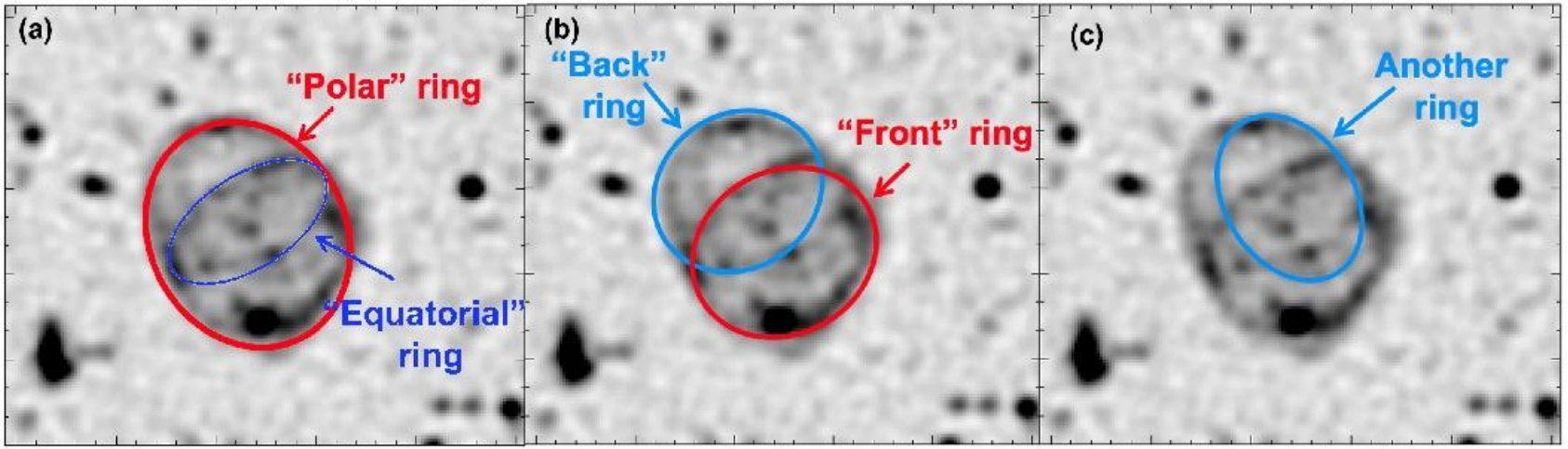
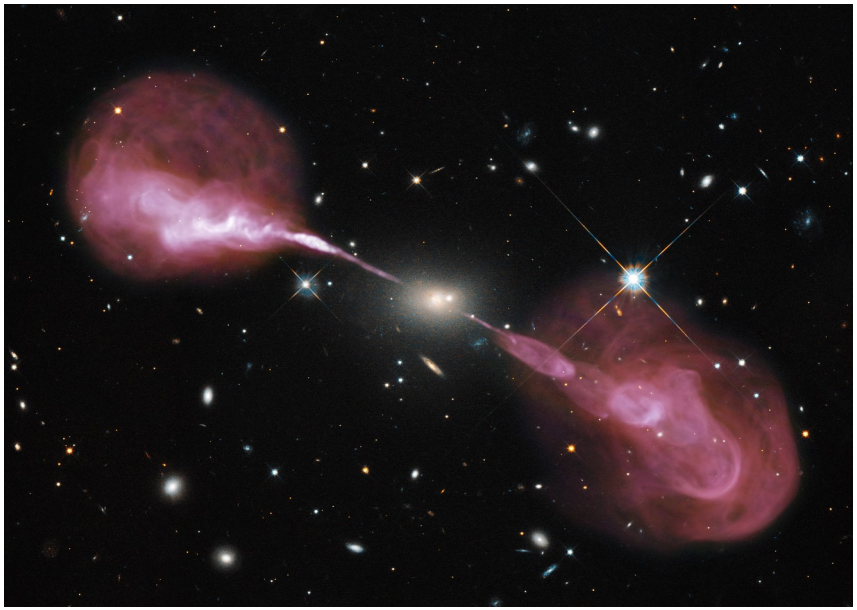


Figure 14. Some potential interpretations of the structures seen within the ring of the MeerKAT image of ORC1. (a) suggests that the outer or "polar" ring is the edge-brightened limb of a shell, which also has an equatorial ring formed by another mechanism. (b) interprets the morphology as a front ring and a back ring, possibly caused by a biconical outflow. Finally, we note the existence of other structures within the ORC, such as a potential faint ring shown in (c), distinct from the other rings.

Источники:

- Слияние двух сверхмассивных черных дыр 100 млн лет назад
- Джет из активного ядра радиогалактики
- Терминальная ударная волна галактического ветра от вспышки звездообразования

Ну например, второй вариант… Но где лацертид??



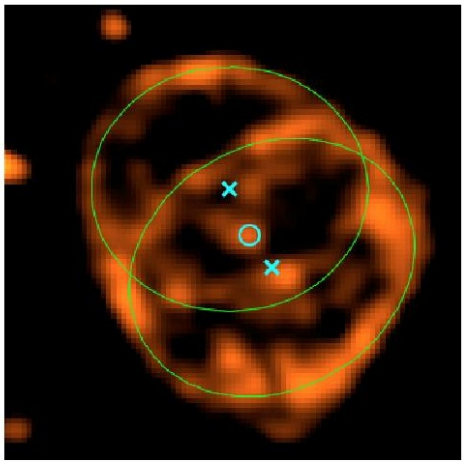


Figure 16. Two ellipses fitted to the Meerkat image. The centre of each ellipse is marked with an X.

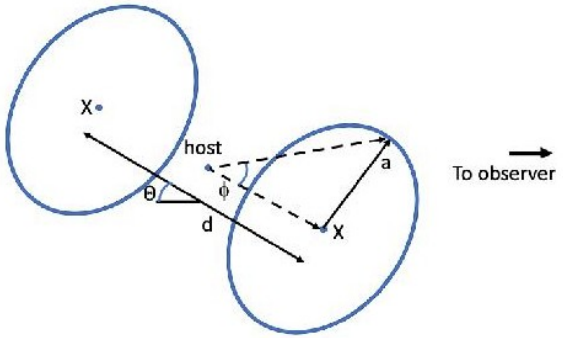


Figure 17. A model of the two ellipses shown in Figure 16, that might be caused by a cylindrical or bipolar outflow from the host, or possibly a precessing radio jet.

У всех моделей – свои недостатки…

- Которые можно преодолеть; но нужно еще наблюдать!