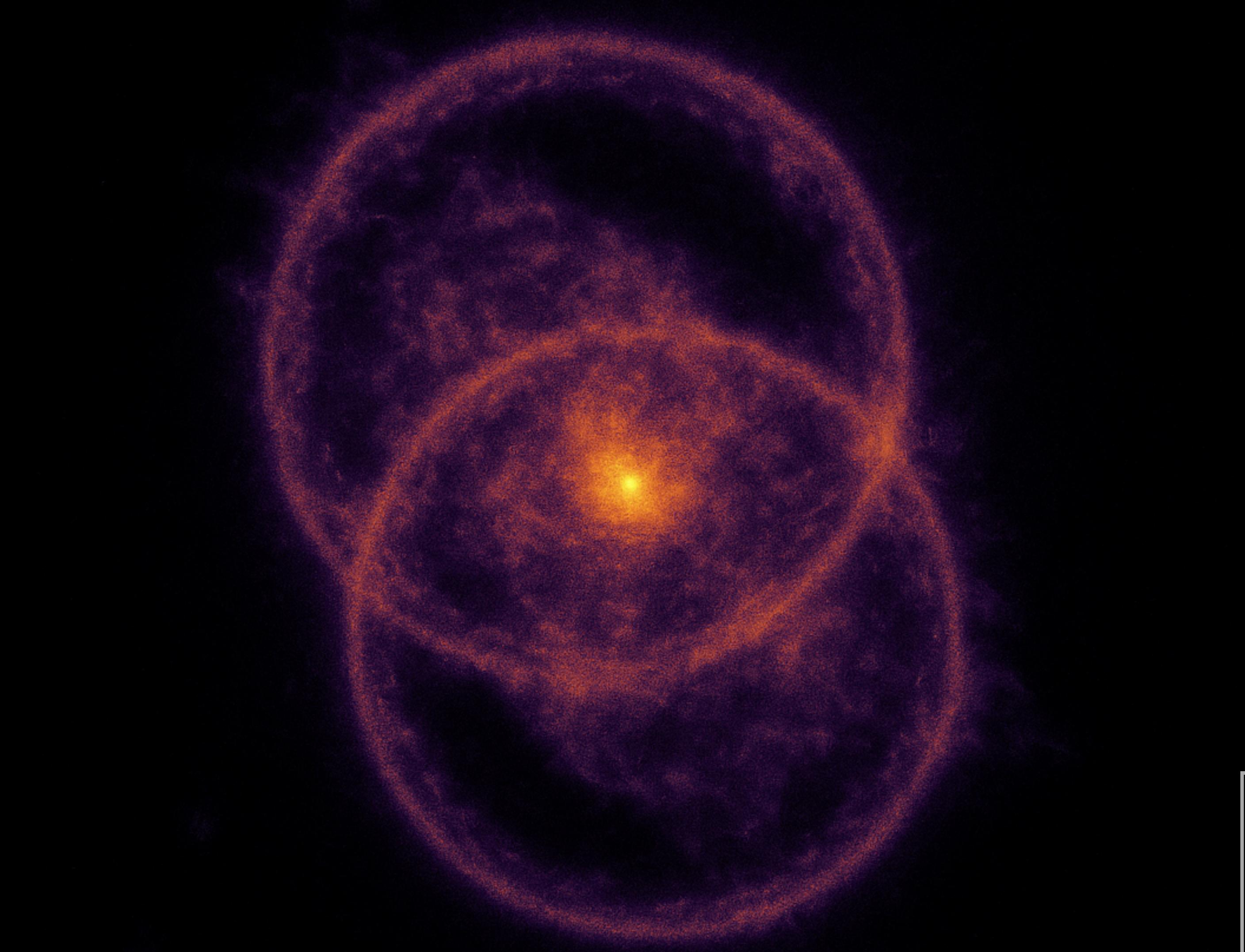


# Discovery of extragalactic radio rings & Odd radio circles



Pratik Dabhade  
(NCBJ, Poland)



# Discover the Universe from Home: The RAD@home Model

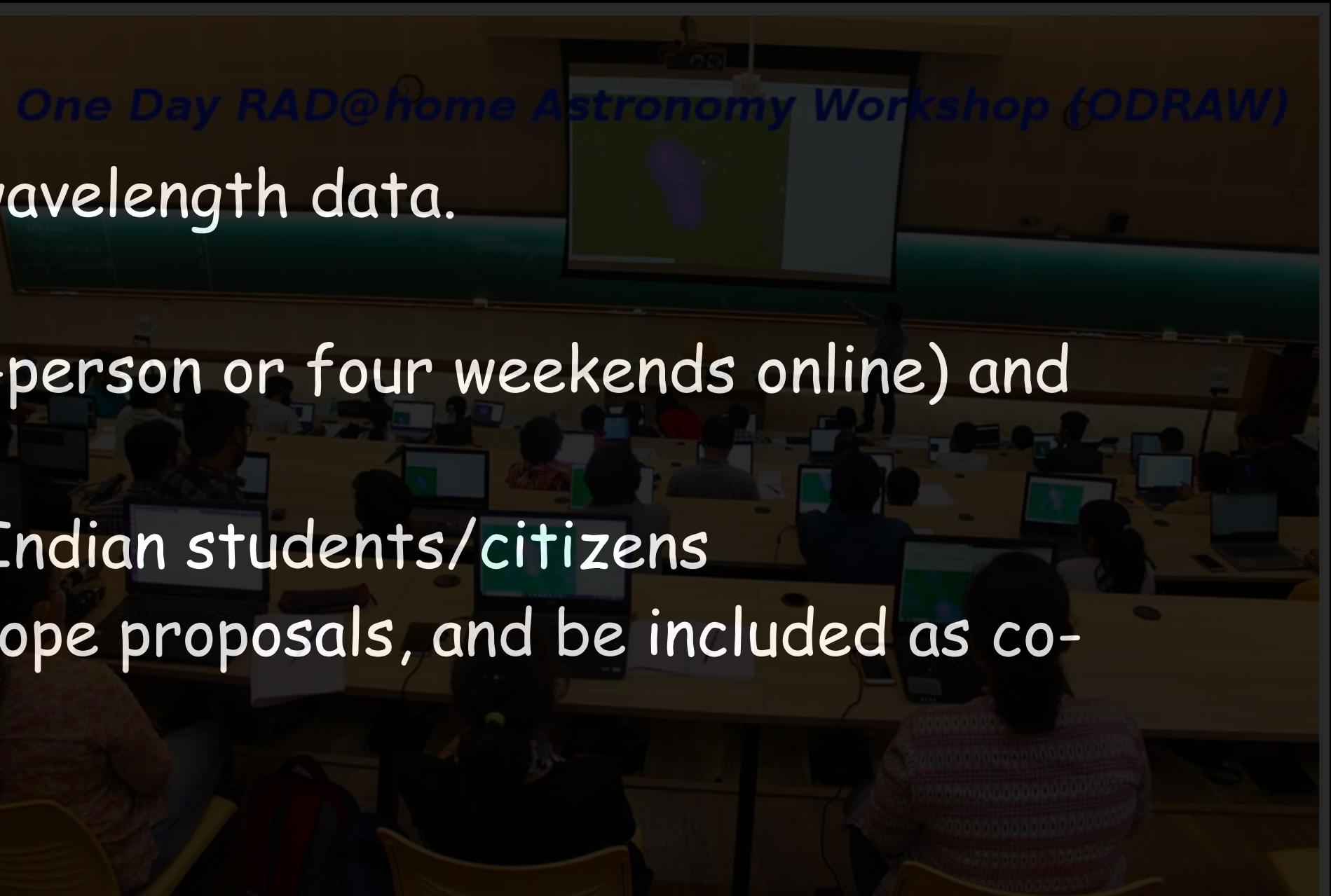


## India's first astronomy citizen science collaboratory

<https://www.radathomeindia.org/>

- It is an internationally-acclaimed, nationwide, Inter-University collaboratory
- The model is zero-funded and zero-infrastructure
- Its mostly online using social media tools since 2013.
- To study Extragalactic objects, mainly using radio and other multi-wavelength data.

- The model is zero-funded and zero-infrastructure
- Most training is done online using social media tools since 2013.
- To study Extragalactic objects, mainly using radio and other multi-wavelength data.
- The model has produced over a thousand trained citizen scientists.
- Training methods include RAD@home Discovery Camps (one week in-person or four weekends online) and Astronomy Workshops (one/two days online/in-person)
- The online group currently has ~1500 active learners out of ~5000 Indian students/citizens
- Successful participants can contribute to discoveries, submit telescope proposals, and be included as co-authors in publications
- Recognised by IAU & SKAO.



#ABCDresearch  
Any BSc/BE Can Do Research



# Citizen science driven discoveries

Monthly Notices  
of the  
ROYAL ASTRONOMICAL SOCIETY



MNRAS **543**, 1048–1057 (2025)  
Advance Access publication 2025 October 2

<https://doi.org/10.1093/mnras/staf1531>

## RAD@home discovery of extragalactic radio rings and odd radio circles: clues to their origins

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# The Odd radio circles (ORCs)



Credit: Science

An artist's impression of an odd radio circle. The mysterious rings could be the result of gas blasted out of a central galaxy after a burst of star formation. CSIRO

## Vast & Circular

They appear as huge edge-brightened circles  
On the sky (~ few arcminutes in diameter)

## Radio- Only

Only visible in radio continuum and no multi-wavelength counterpart of the circular structures

## Extragalactic origin

Away from galactic plane and sky distribution rules out local origin.

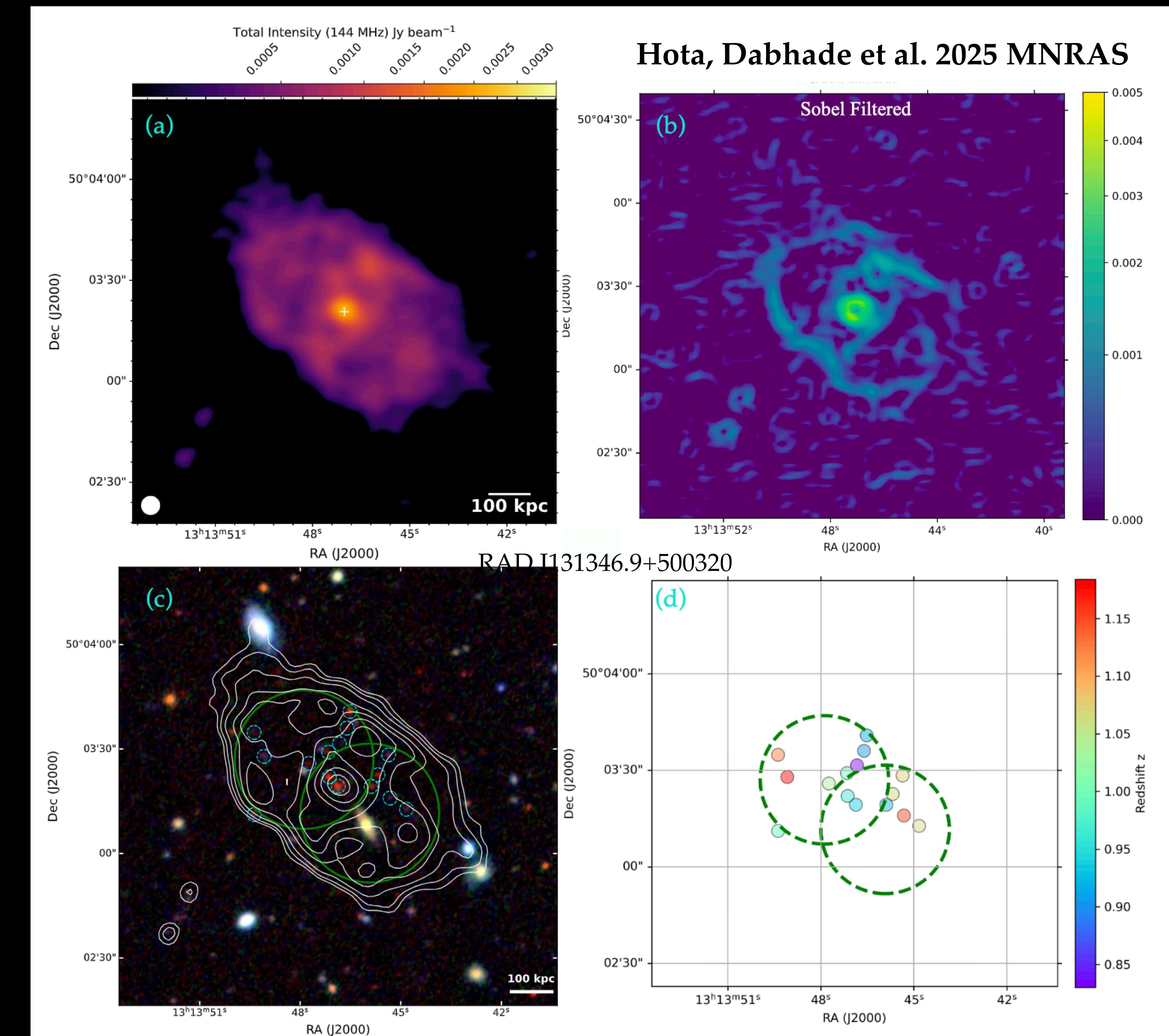
# Odd Radio Circles

- First discovered in 2019
- Only about a dozen examples known to date.

## RAD J131346.9+500320

### The Double-Ring Odd Radio Circle

- Discovery: By RAD@home citizen scientists using LOFAR (LoTSS) data
- Redshift:  $\approx 0.94$
- Physical size:  $\sim 865$  kpc
- Structure: Two intersecting rings - only the second known double-ring ORC
- Environment: Dense galaxy group/cluster; multiple nearby galaxies at similar redshift
- Radio power: Most powerful and most distant ORC known so far.
- Significance: First ORC discovered via citizen science and first found using LOFAR in the northern sky



Hota, Dabhade et al. 2025 MNRAS

# Possible causes for Odd Radio Circles ?

Artist's visualisation of ORC 'RAD J131346.9+500320'

- **Merging black holes or galaxies:** Expanding shockwaves from mergers light up old plasma, forming giant radio rings.
- **Powerful superwinds:** Explosive outflows from starbursts or active galactic nuclei sweep up material into spherical shells seen as rings.
- **Relic radio lobes:** Faded lobes from past jet activity become ring-like when re-energised or compressed.
- **Cluster environment effects:** Interaction between radio plasma and hot intracluster gas sculpts ring or arc-shaped structures.
- **Projection of 3D structures:** Spherical or helical outflows appear as circular rings when viewed from Earth.



Credit: Pratik Dabhade & RAD@home astronomy collaboratory

# RAD@home discovery of extragalactic radio rings and odd radio circles: clues to their origins

Overview of attention for article published in Monthly Notices of the Royal Astronomical Society, October 2025



SUMMARY

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Published in Monthly Notices

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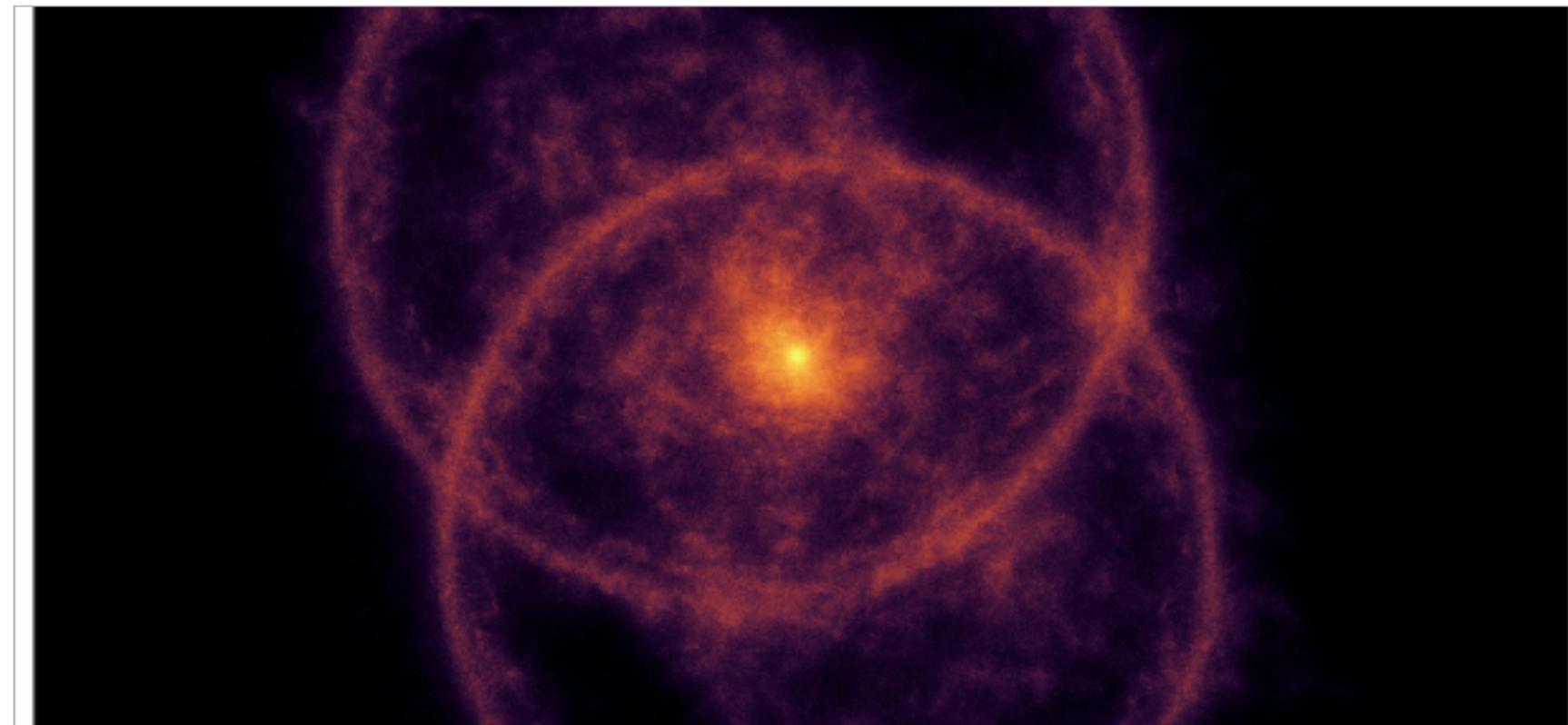
CNN Science

Astronomers discover rare radio circle in space

OCT 14, 2025

In the Spotlight of International Press

Narodowe Centrum Badań Jądrowych  
National Centre for Nuclear Research  
ŚWIERK



**Astrofizyk NCBJ jednym z odkrywców największego „nietypowego kręgu radiowego”**

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## Most powerful 'odd radio circle' to date discovered

by Royal Astronomical Society

edited by Lisa Lock, reviewed by Robert Egan

Editors'

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RESEARCH HIGHLIGHT | 09 October 2025

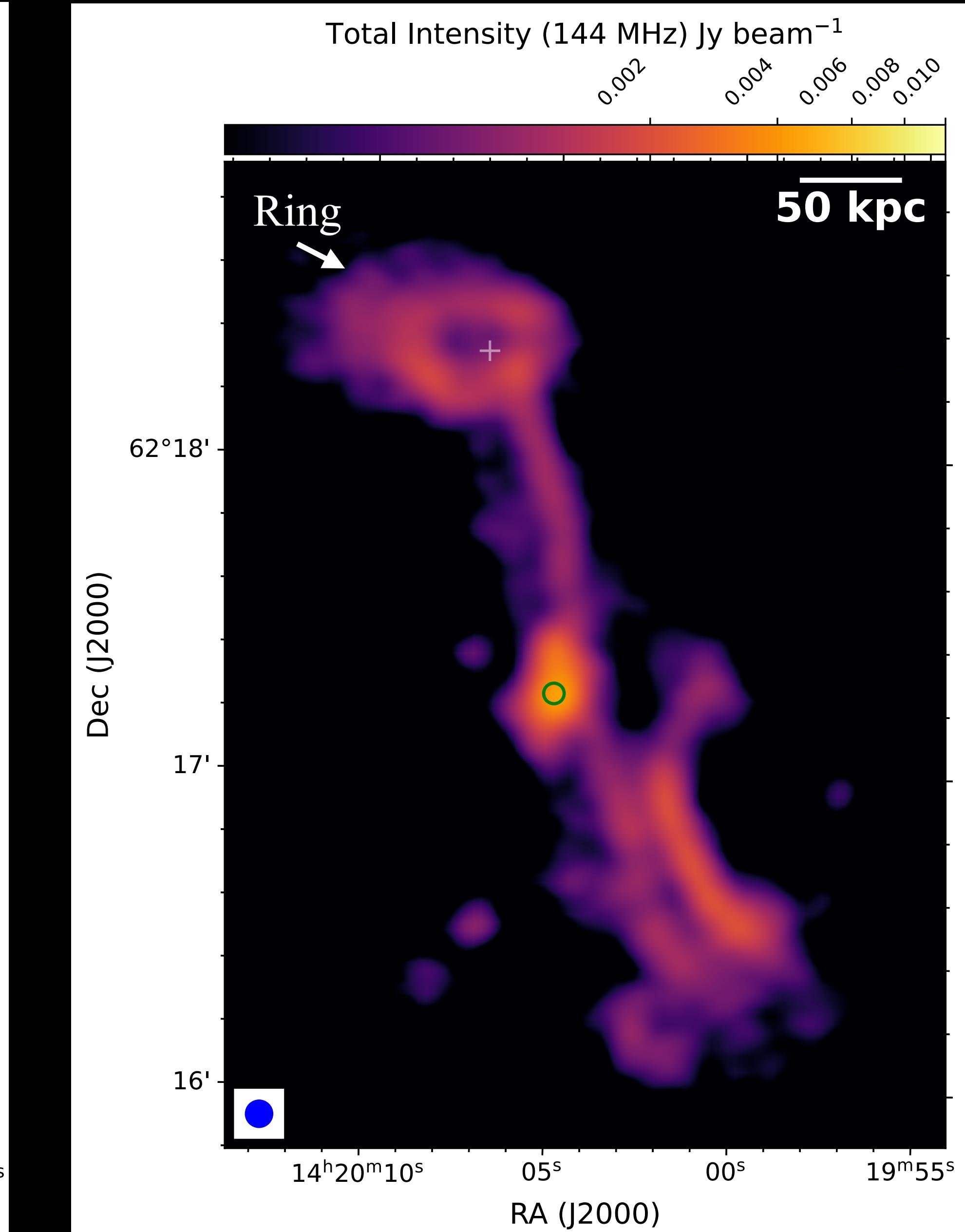
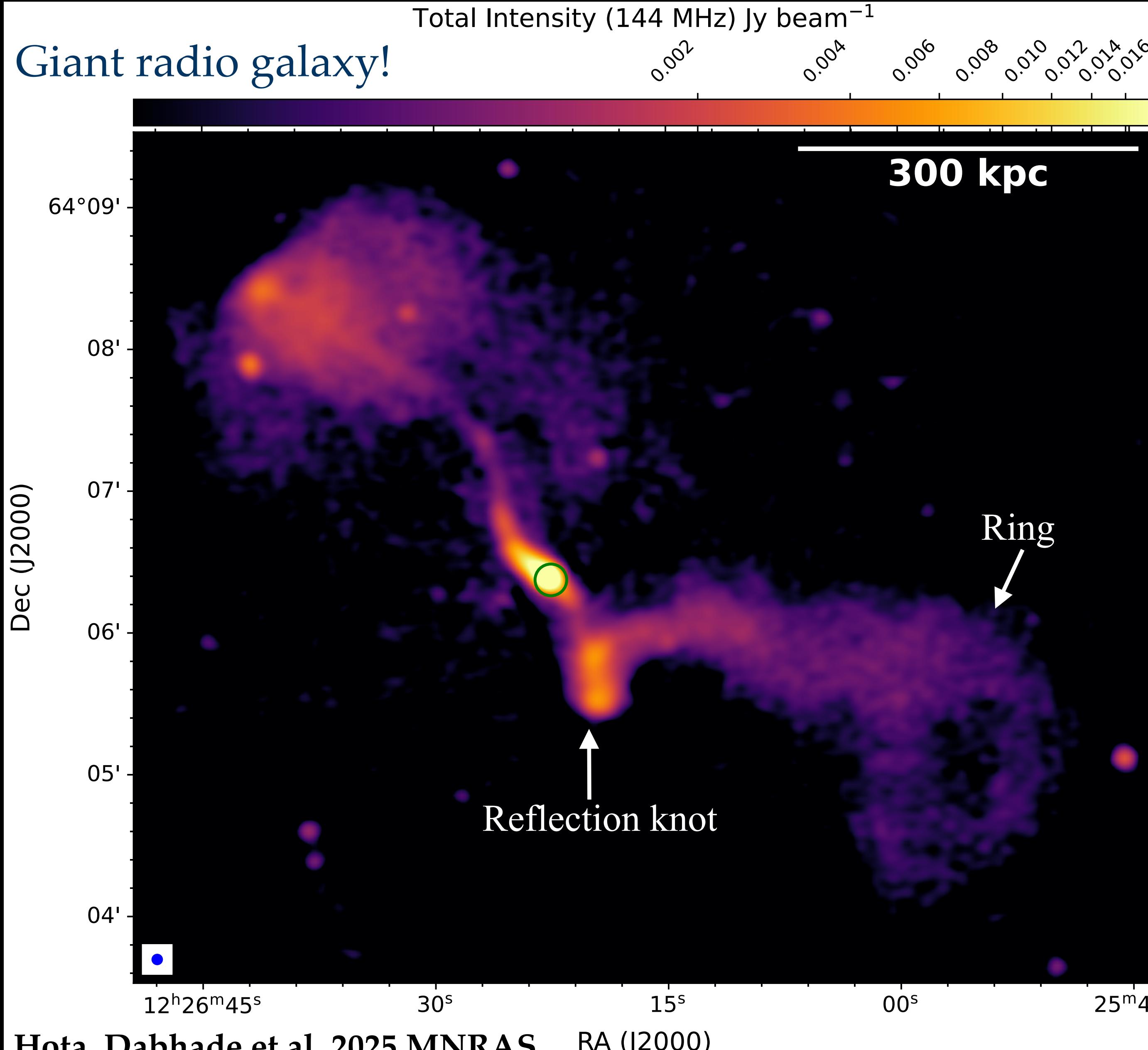
## Most powerful 'Odd Radio Circle' so far discovered

Farthest example of relatively new astronomical phenomenon spotted with help of citizen scientists.

# Rare radio rings in radio galaxies



Strong interaction with turbulent cluster environment



- Current deep radio surveys are revealing objects hidden for over 7 decades!
- Next generation surveys (radio + Optical) will challenge us with lot of data & puzzling objects.

Automated algorithms - Machine learning!

+

Citizen Science !

Thank you