

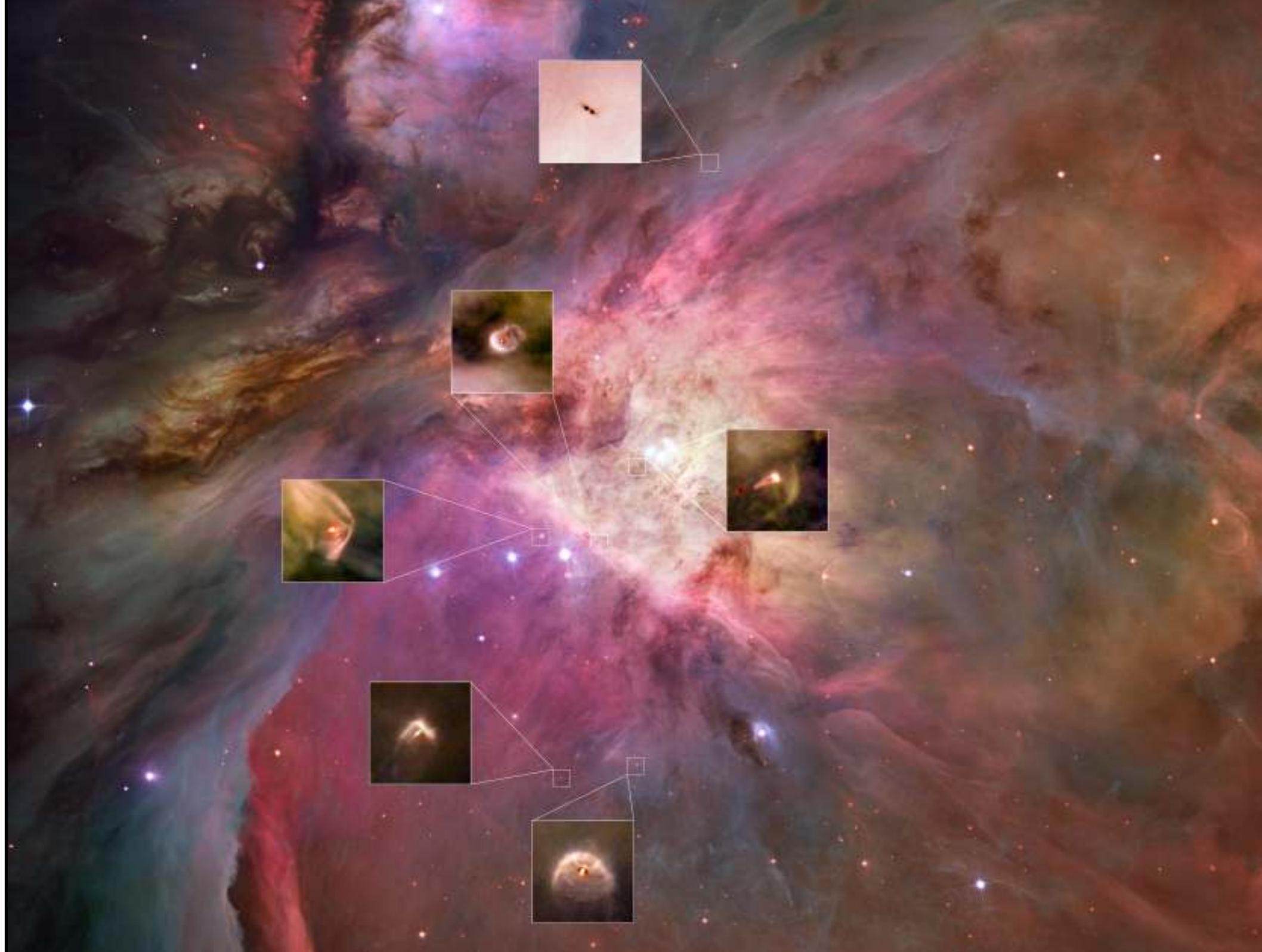
Huub Röttgering Sterrewacht Leiden

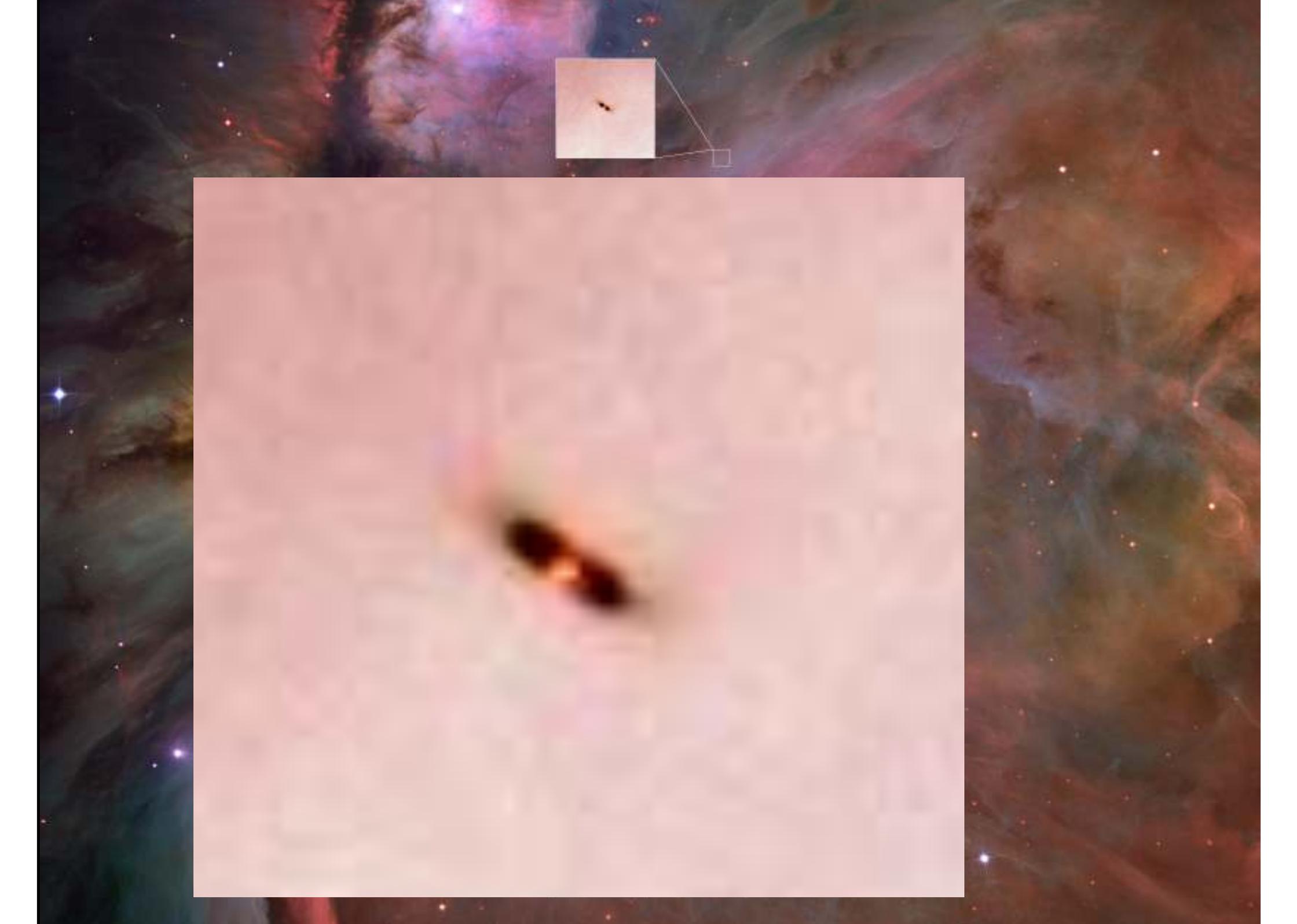




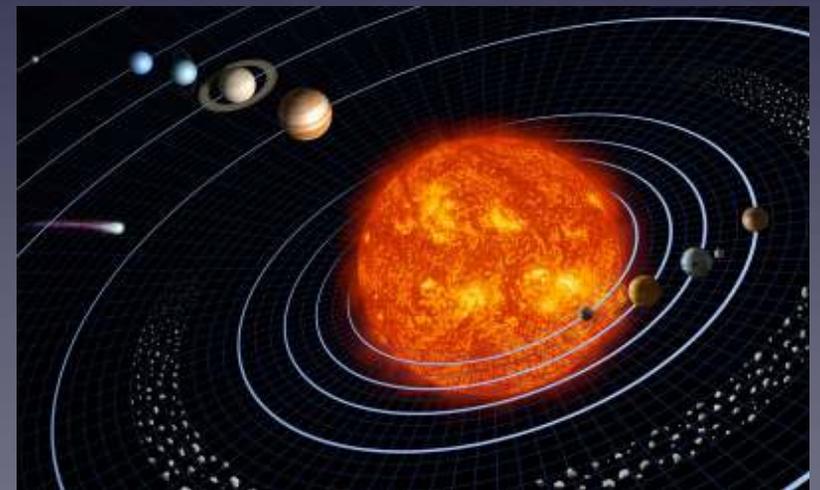




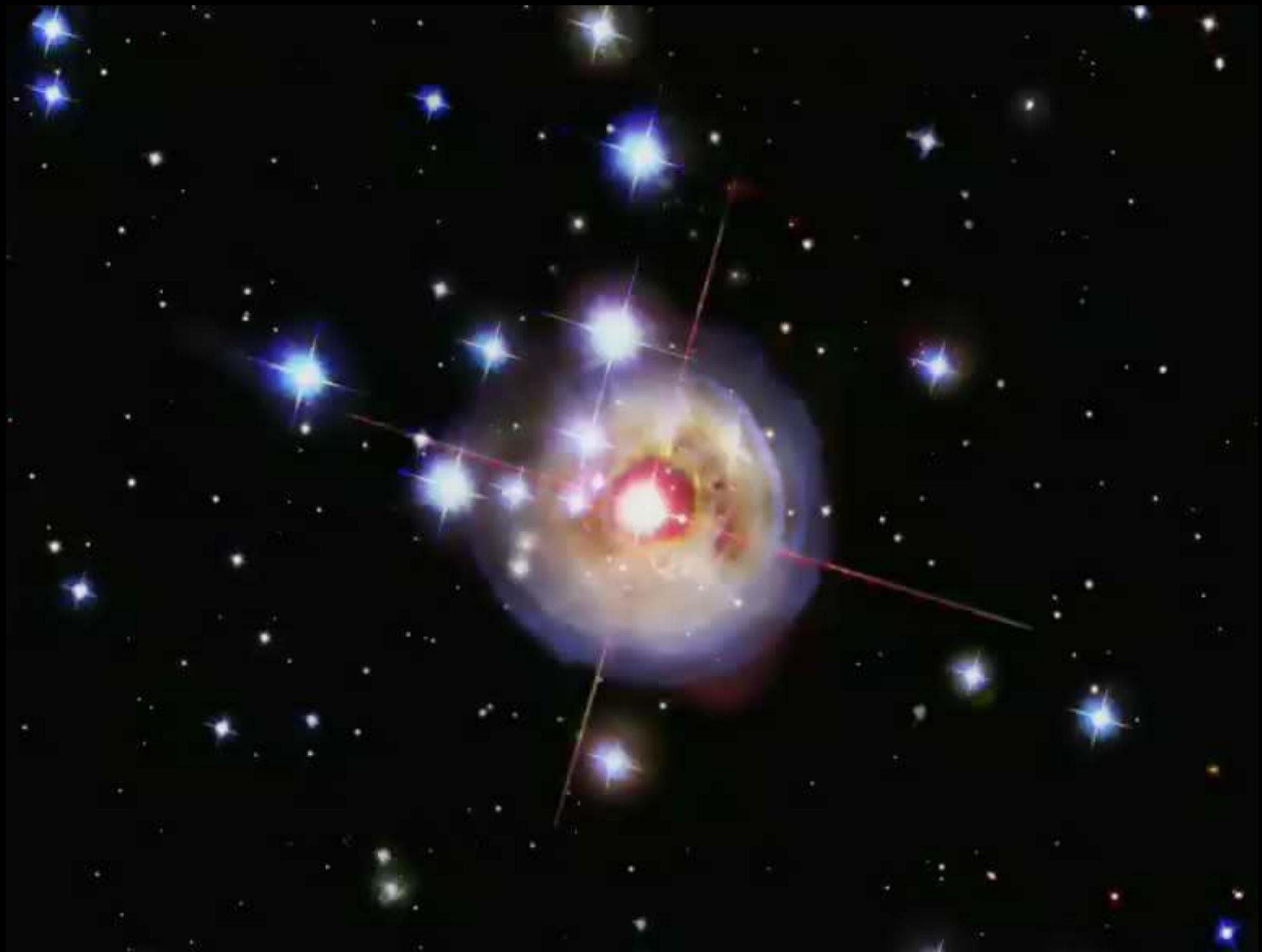


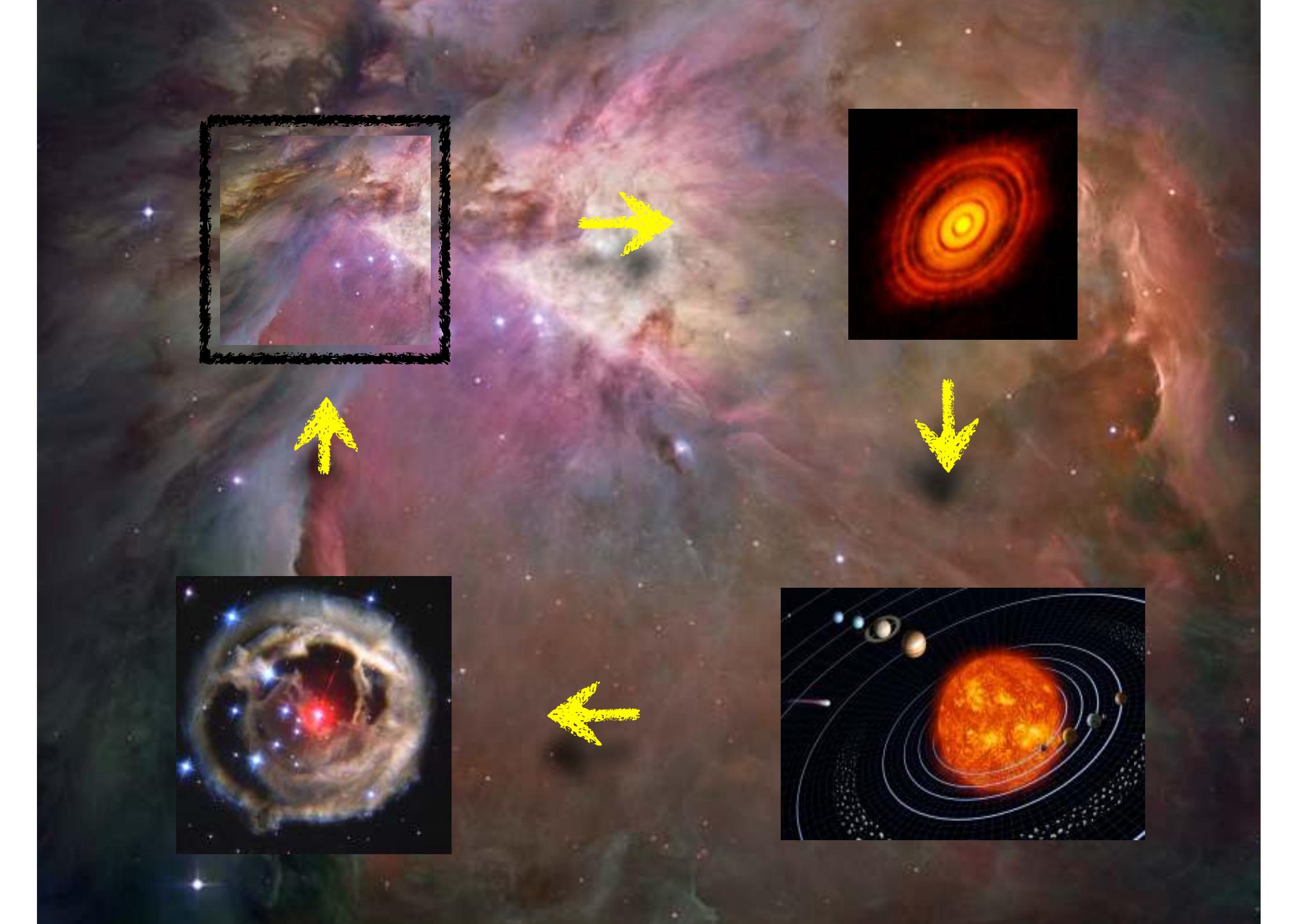






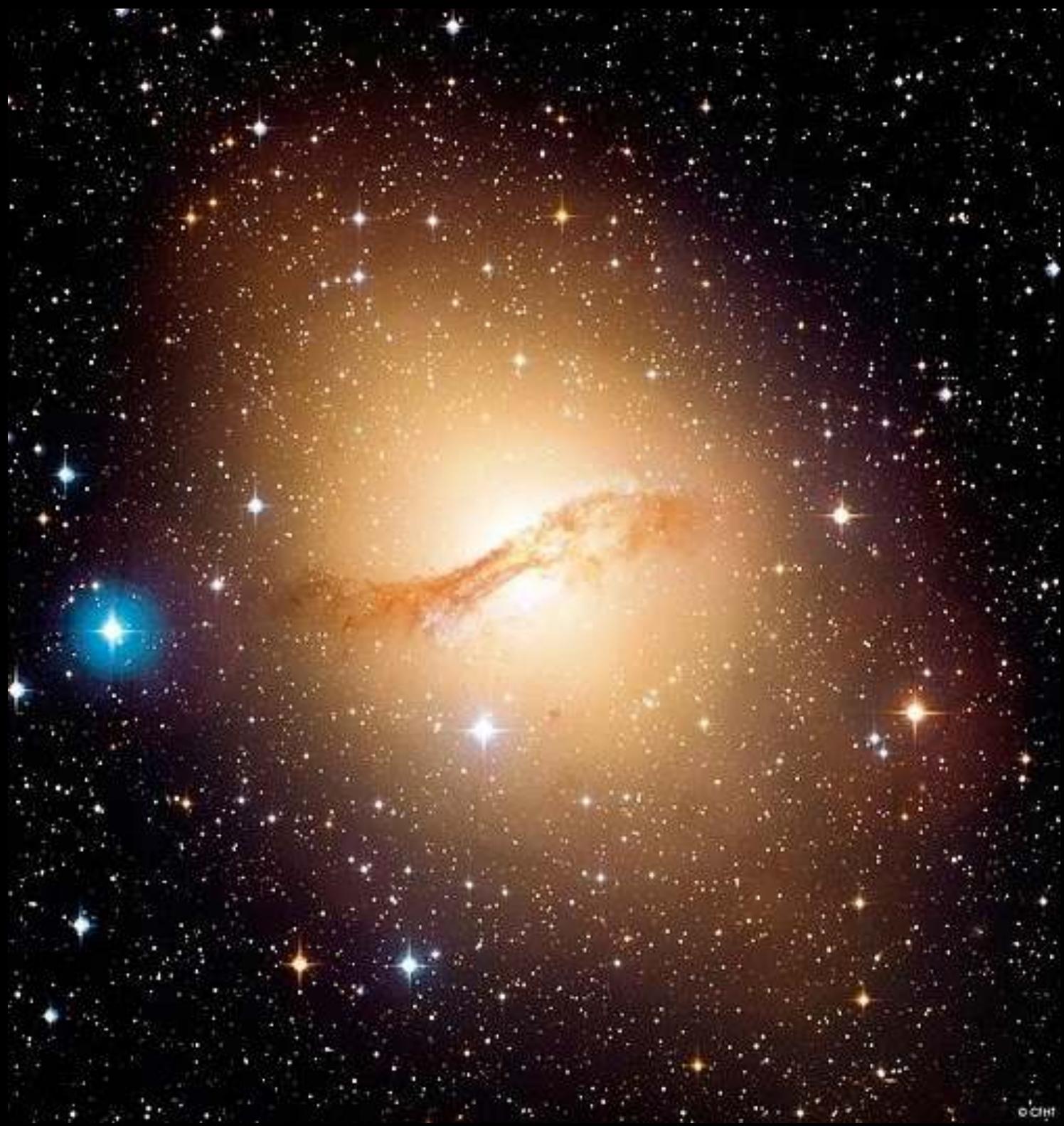


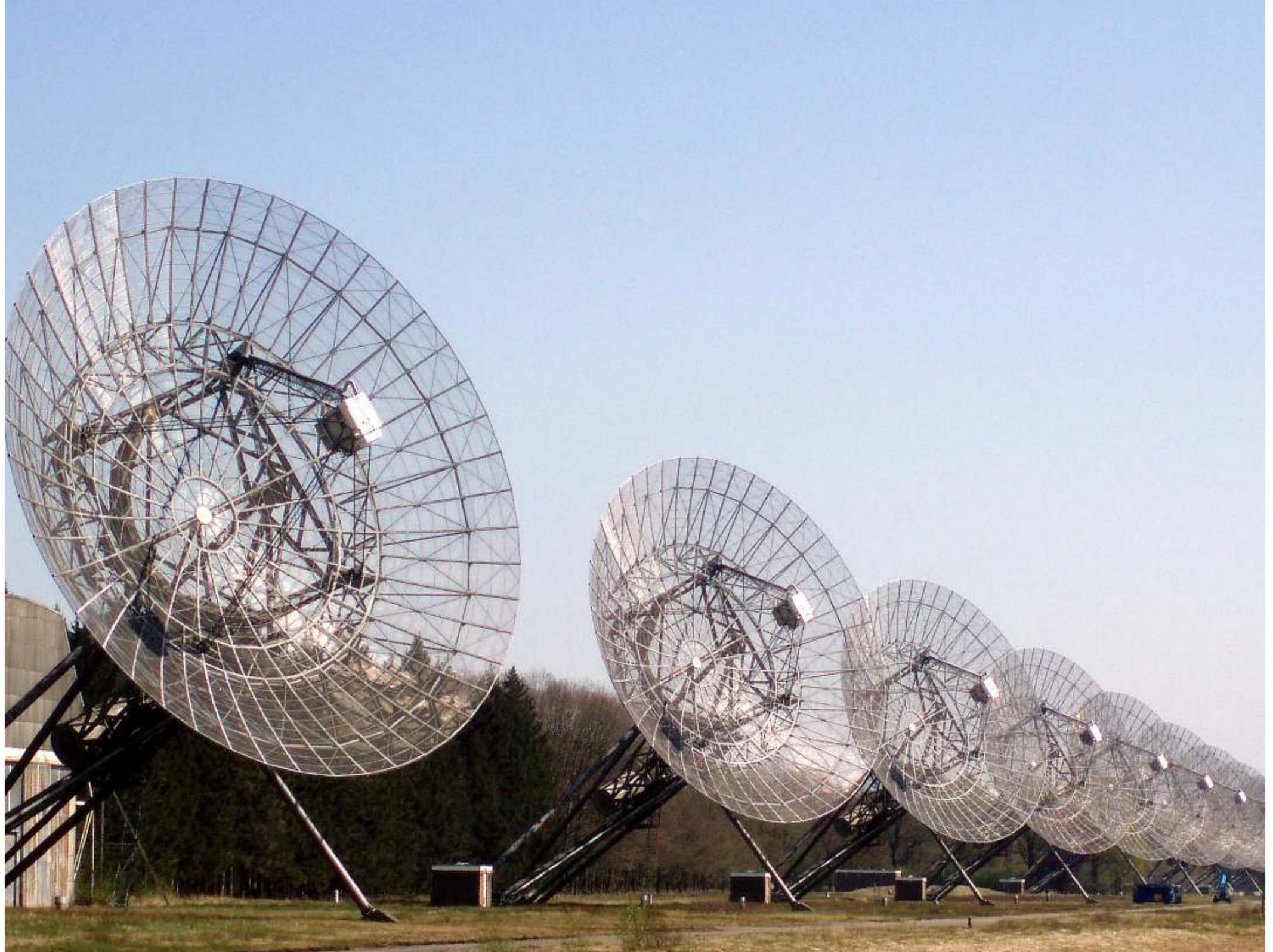








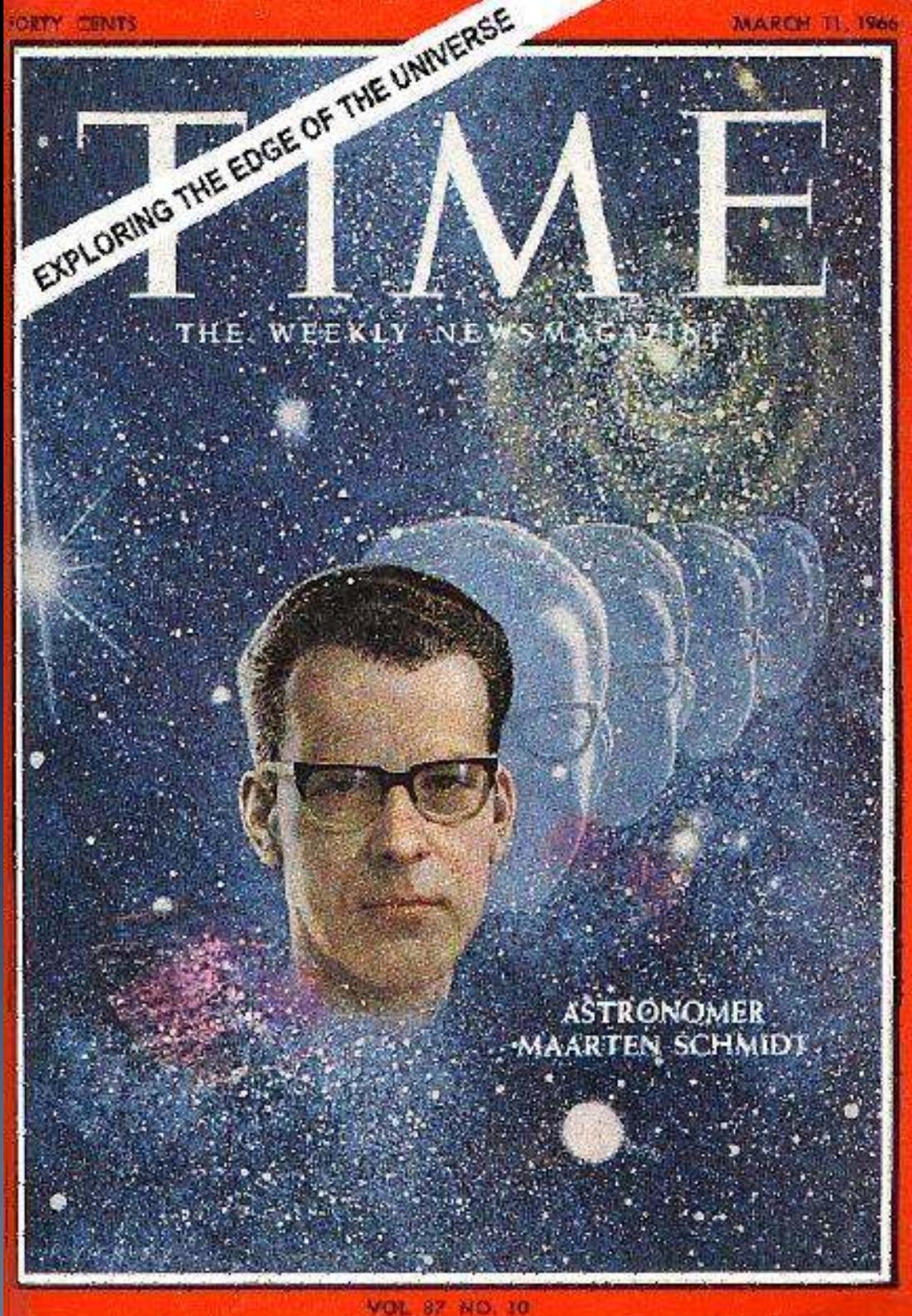






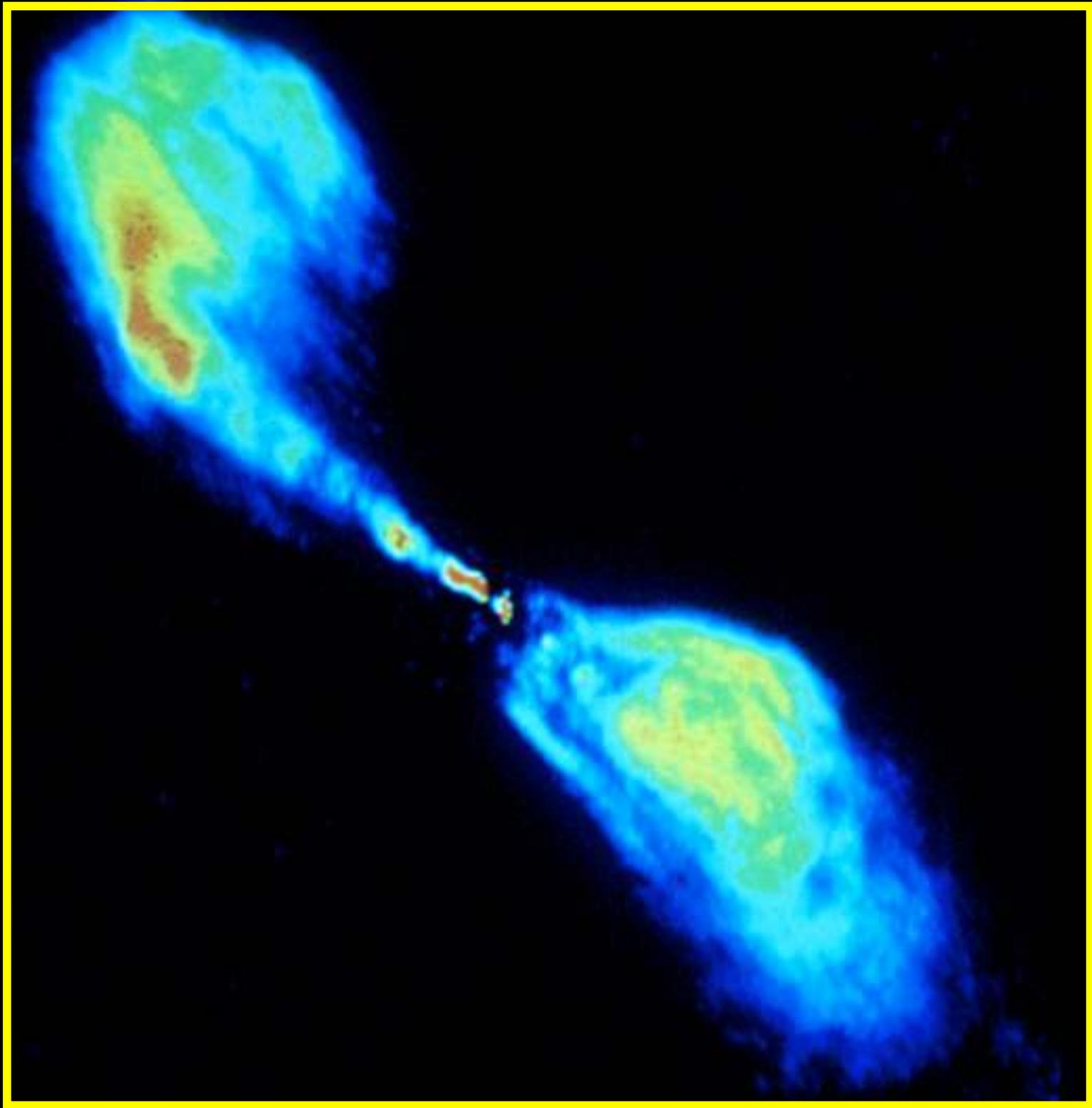
1963: 3C 273

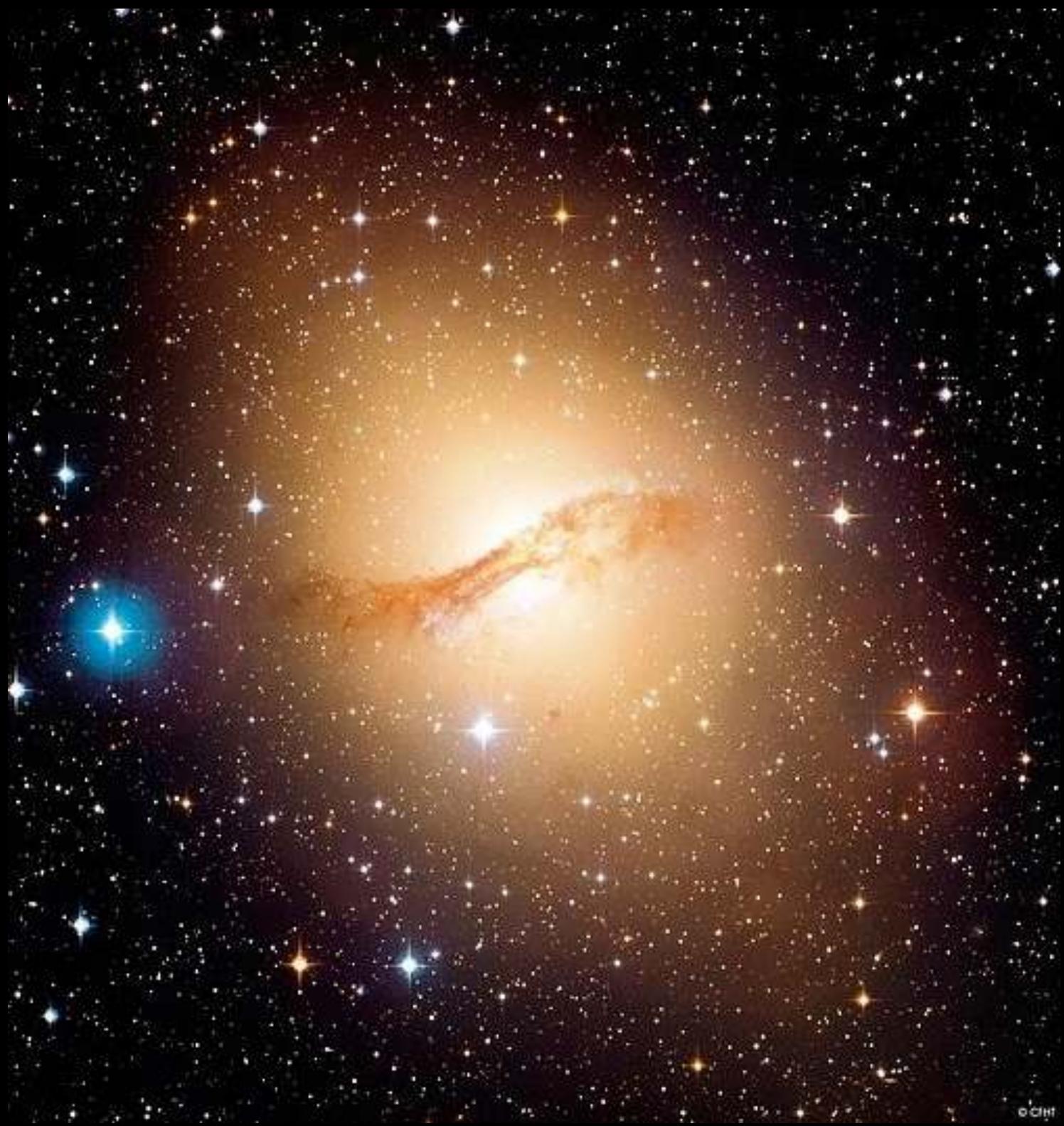
Eerste Quasar

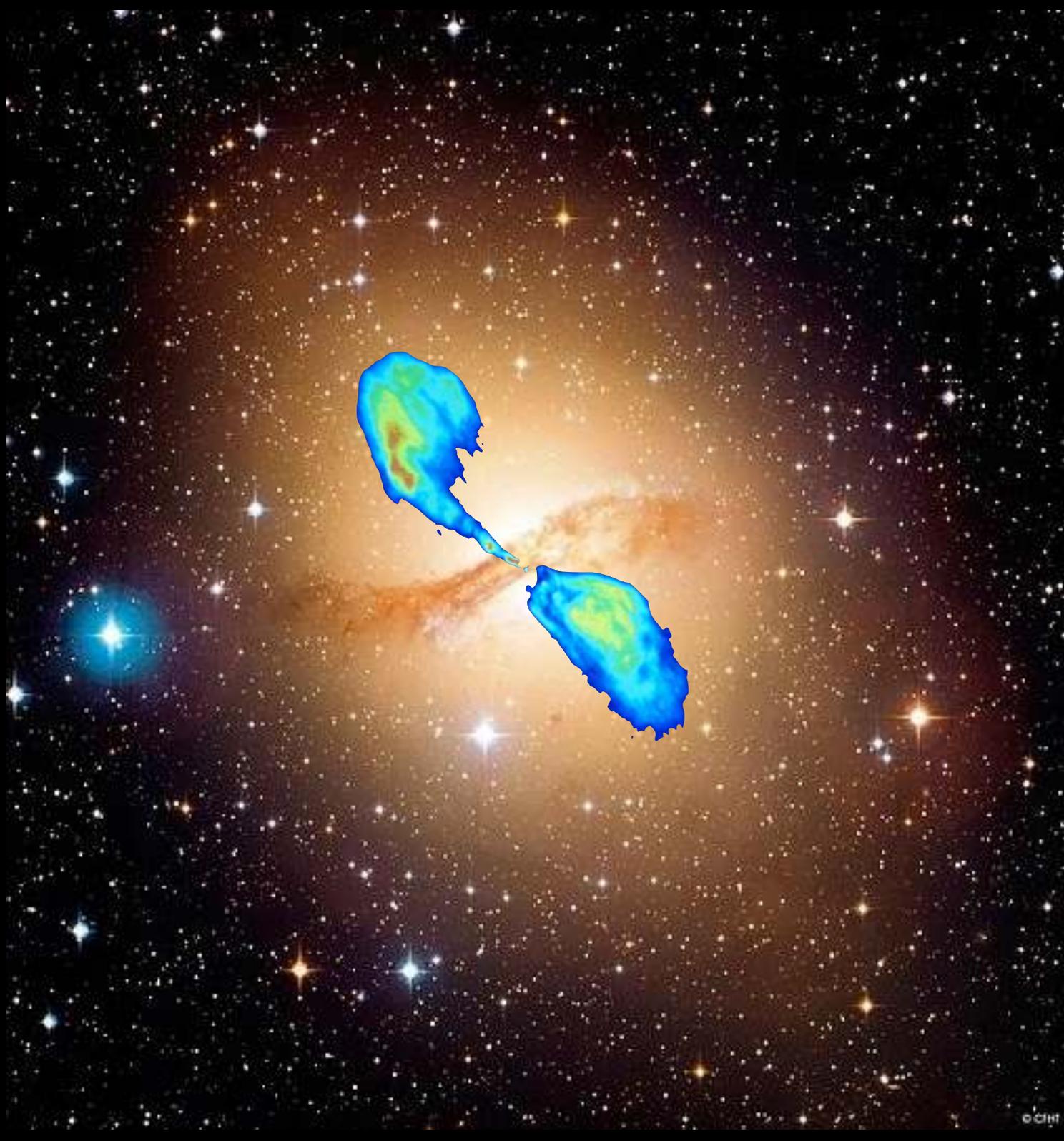


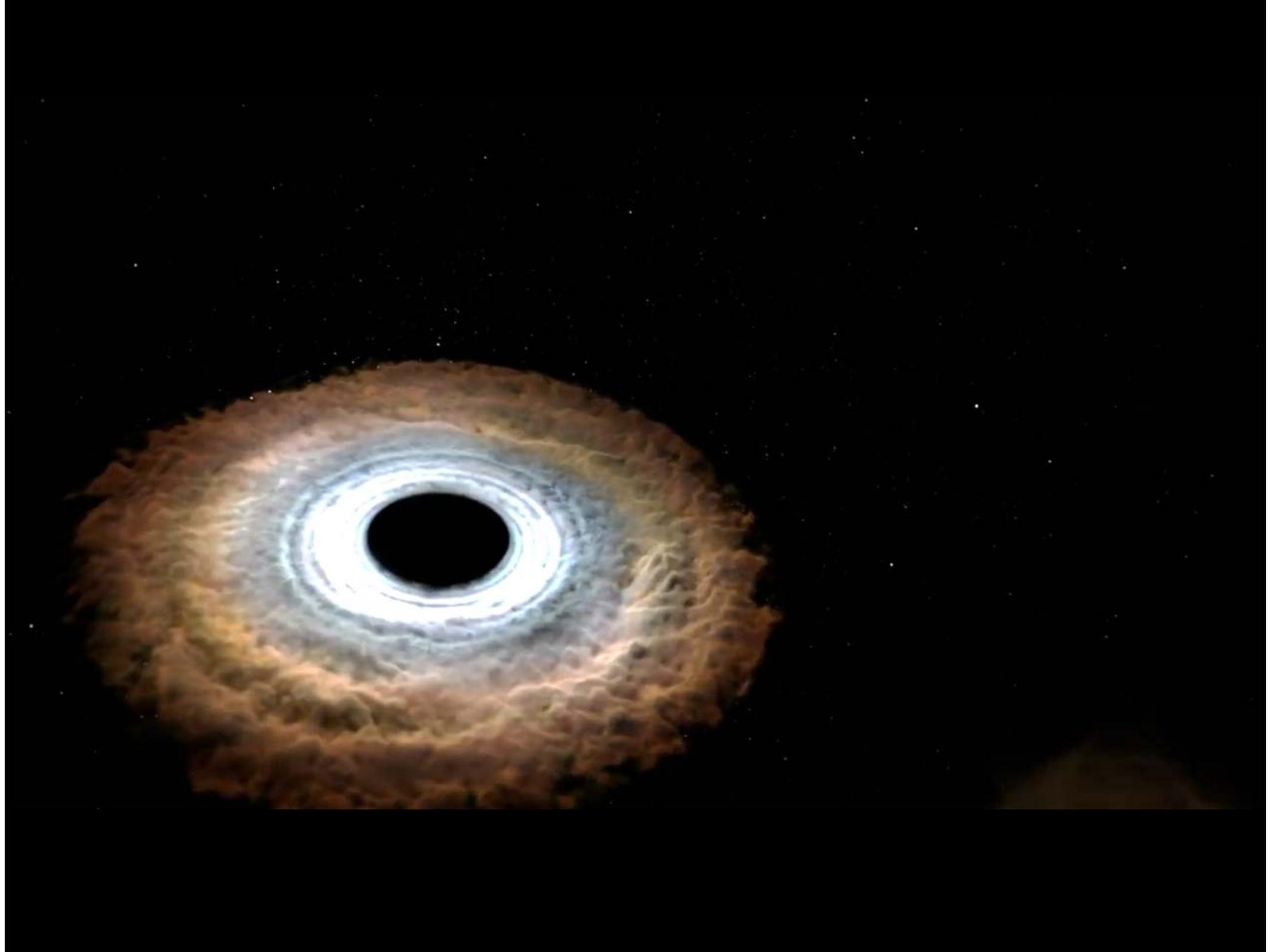












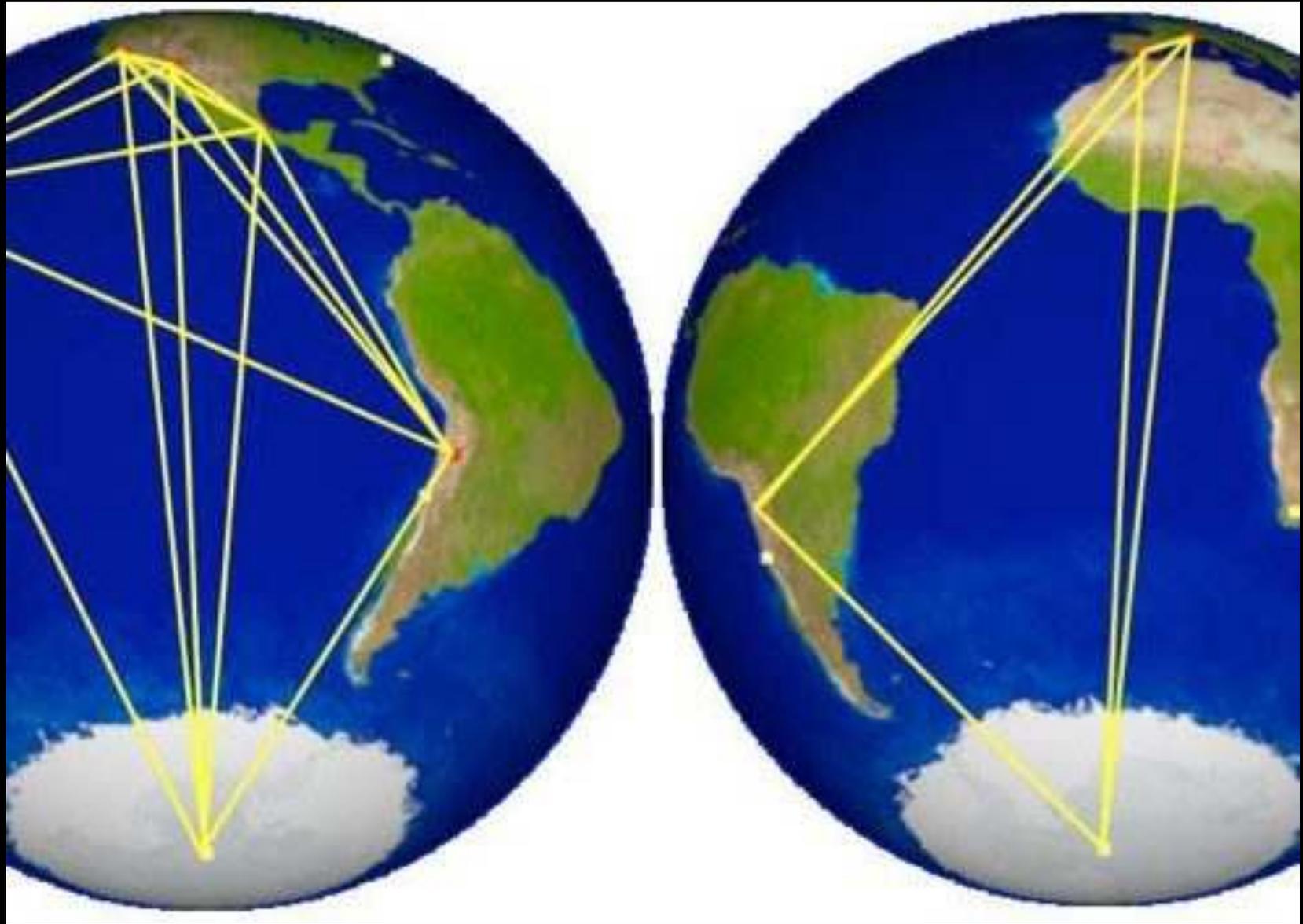
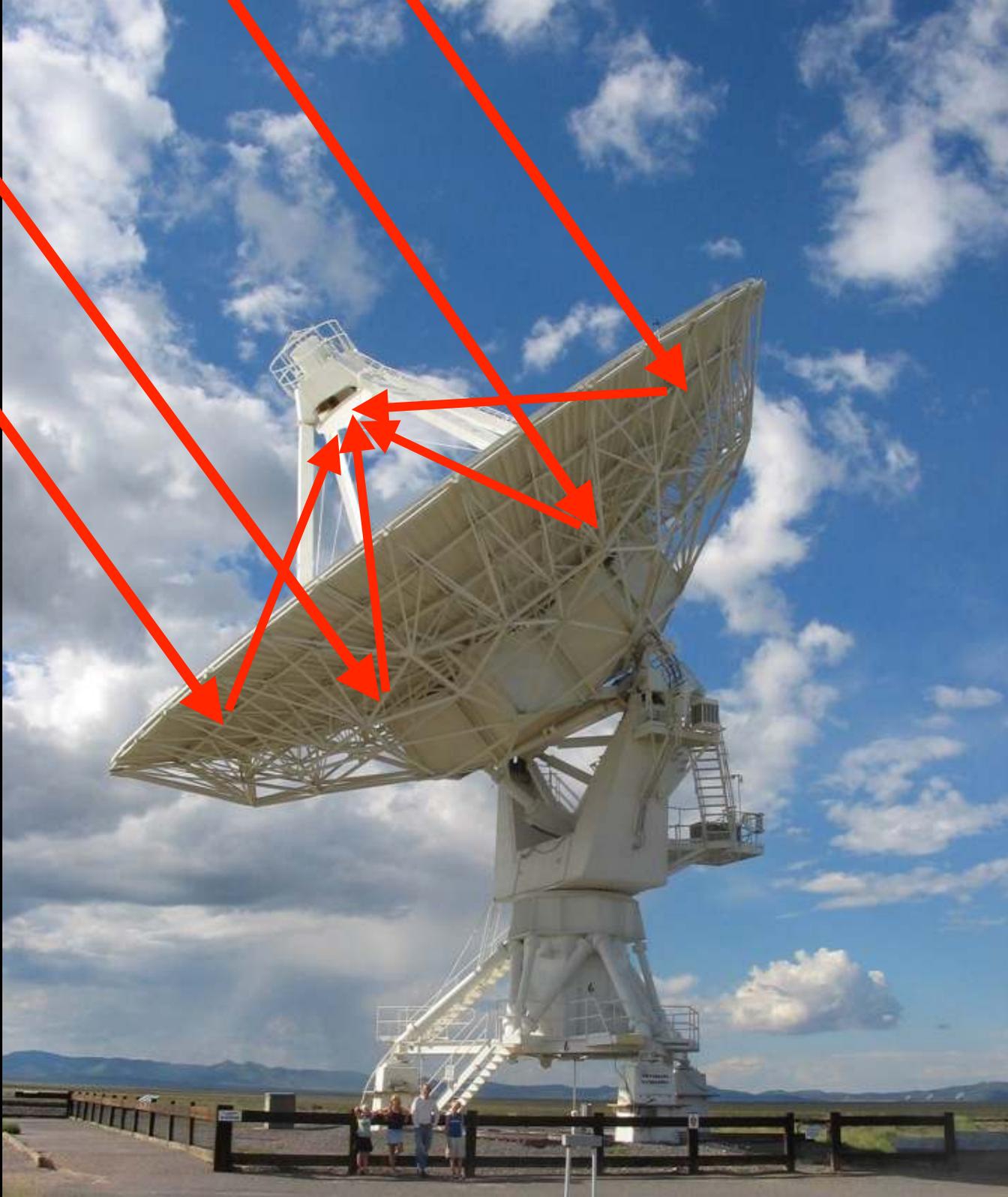


Foto EHT Collaboration



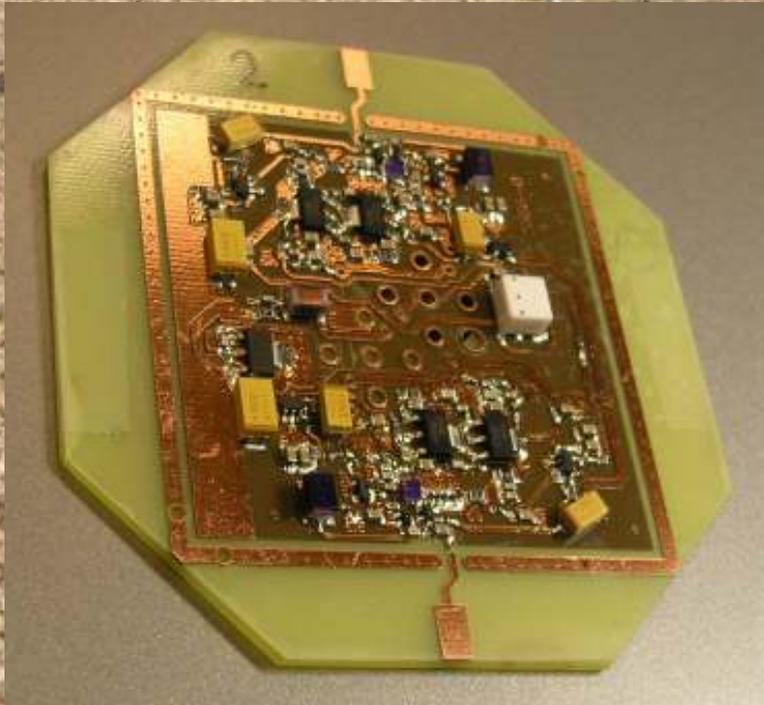
Dit is de allereerste foto van (de schaduw van) een zwart gat



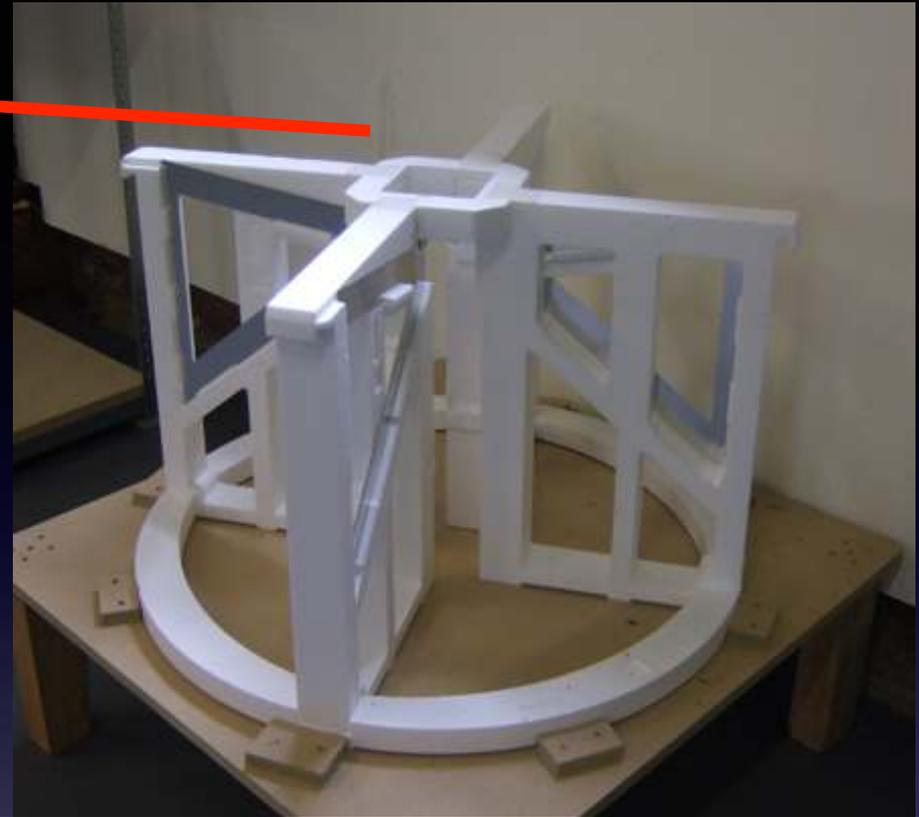
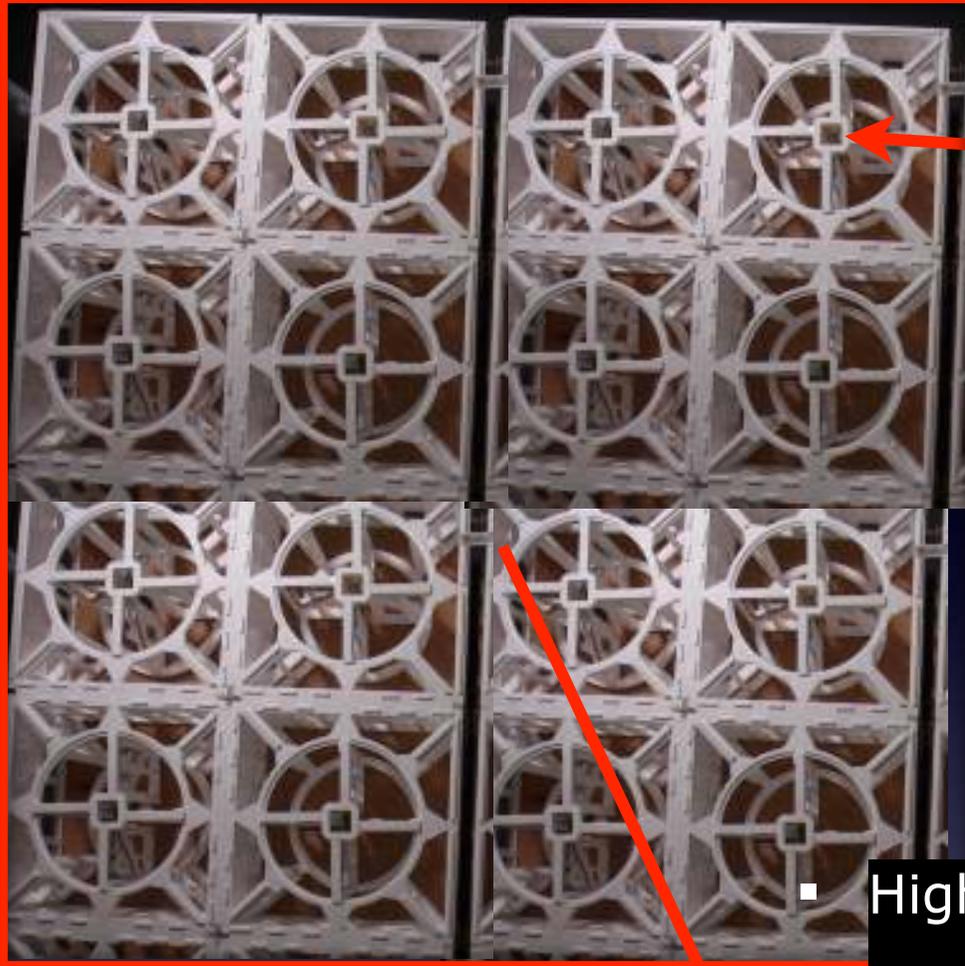












- High-Band Antennas (HBA): 120-200 MHz
- Tiles each contain 16 dipole pairs and an analog beam former; tile signals combined to form digital beam









International LOFAR Telescope (ILT)



Chilbolton



Dutch stations



Onsala

- 47 operational stations completed
- 38 NL stations, 9 international stations
- 3 new stations coming in Poland



Nançay



Unterweilenbach



Łazy

LOFAR Core (NL)

Jülich

Effelsberg

Norderstedt

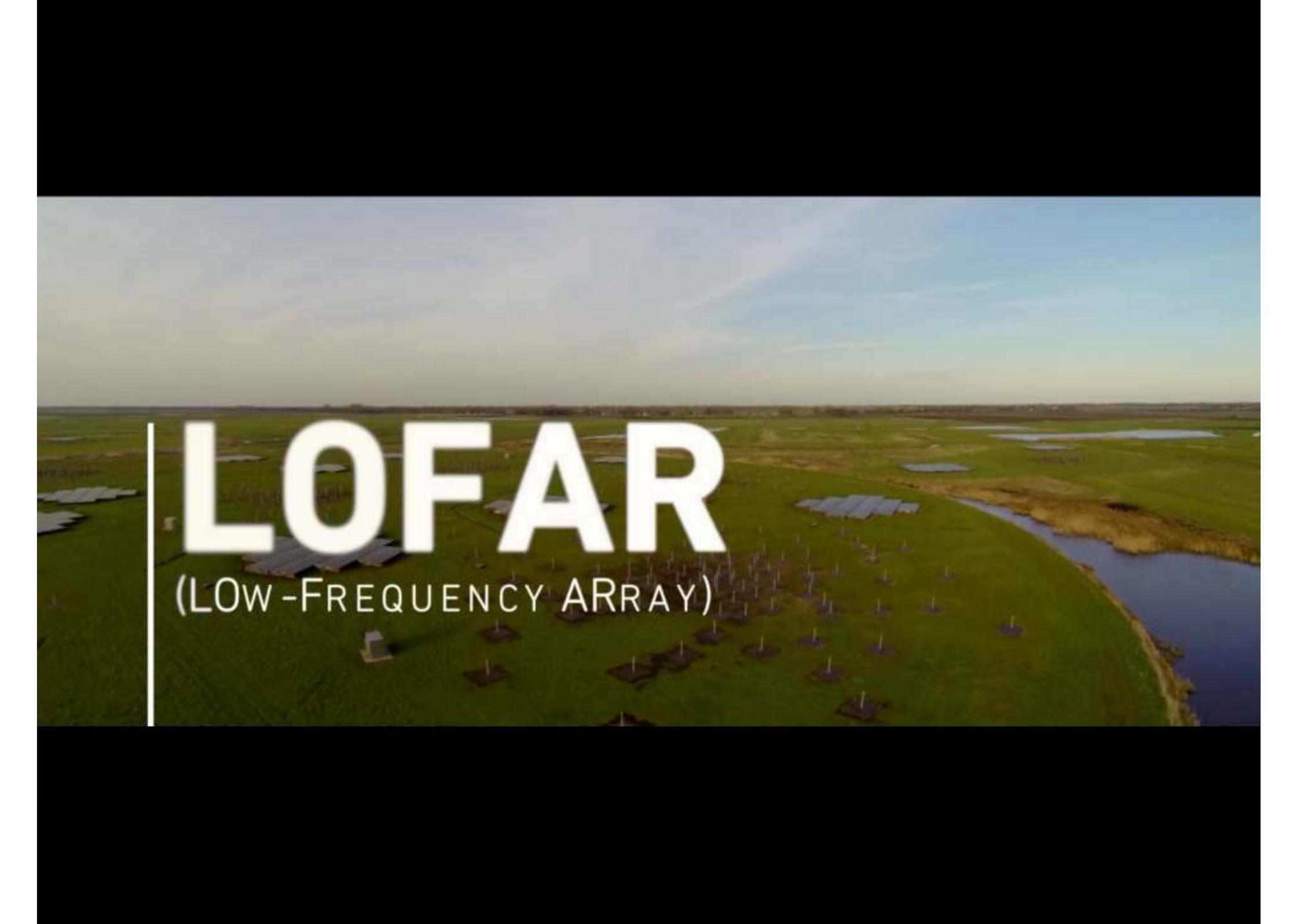
Potsdam

Tautenburg

Borówiec

Baldy



An aerial photograph of a vast green field, likely a golf course, with a winding river on the right side. The field is dotted with numerous small, dark, rectangular structures, which are the antennas of the Lofar radio telescope array. The sky is a pale blue with some light clouds. The text 'LOFAR' is overlaid in large, white, bold letters on the left side of the image.

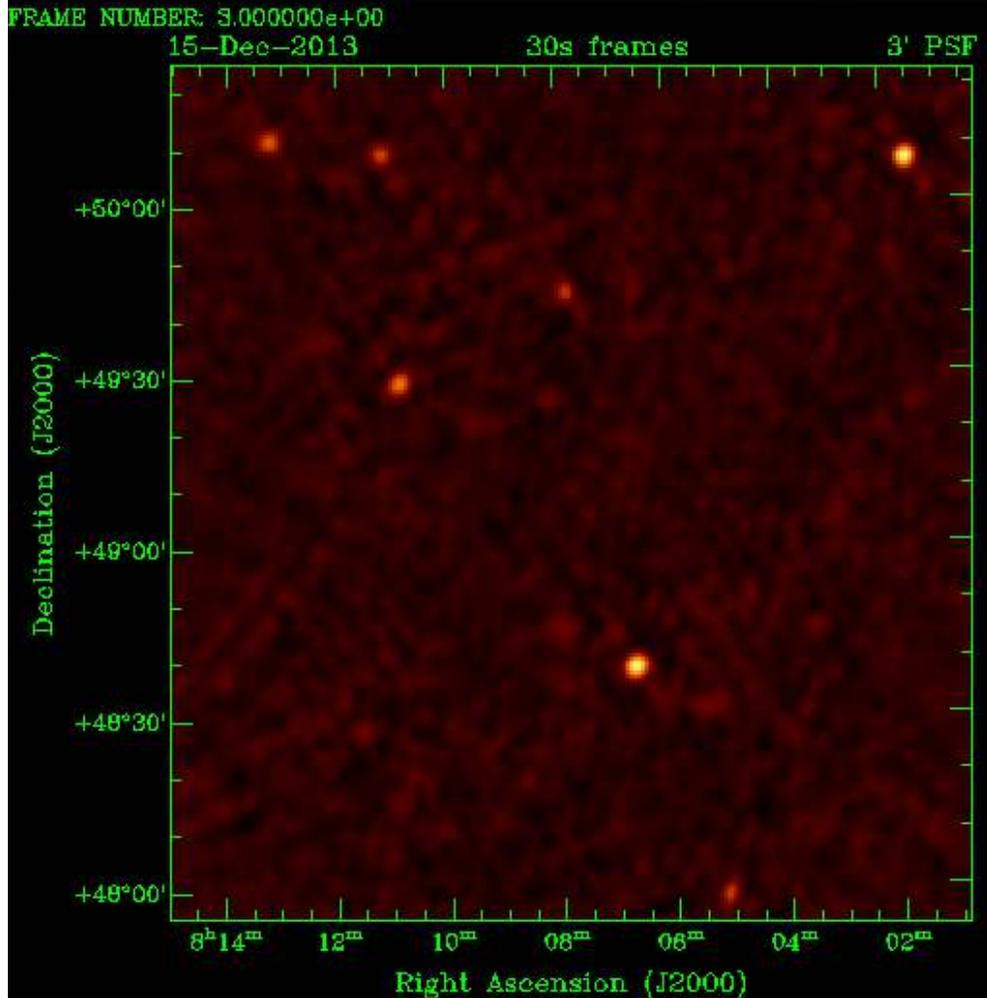
LOFAR

(LOW-FREQUENCY ARRAY)

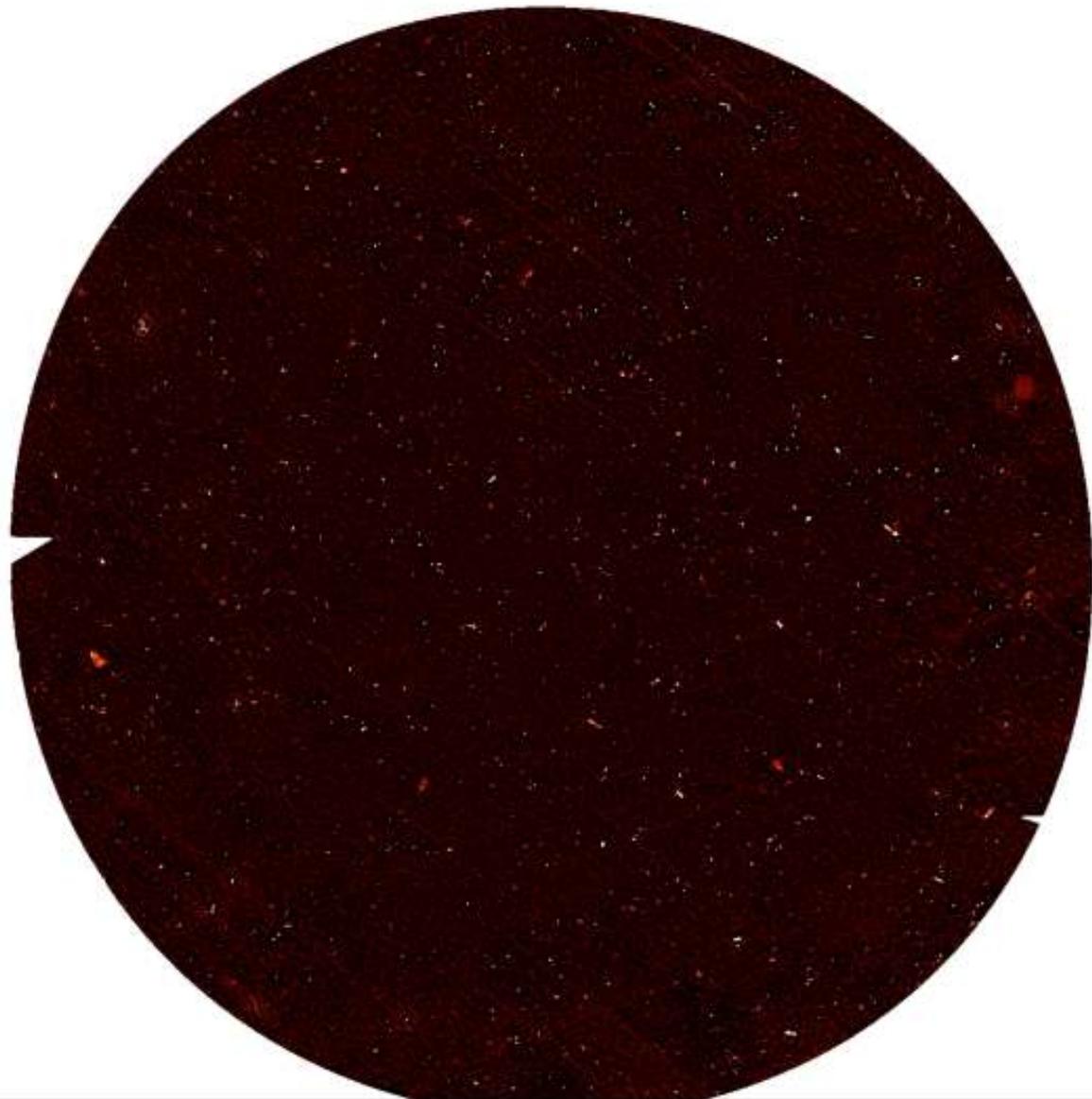
12 Challenges

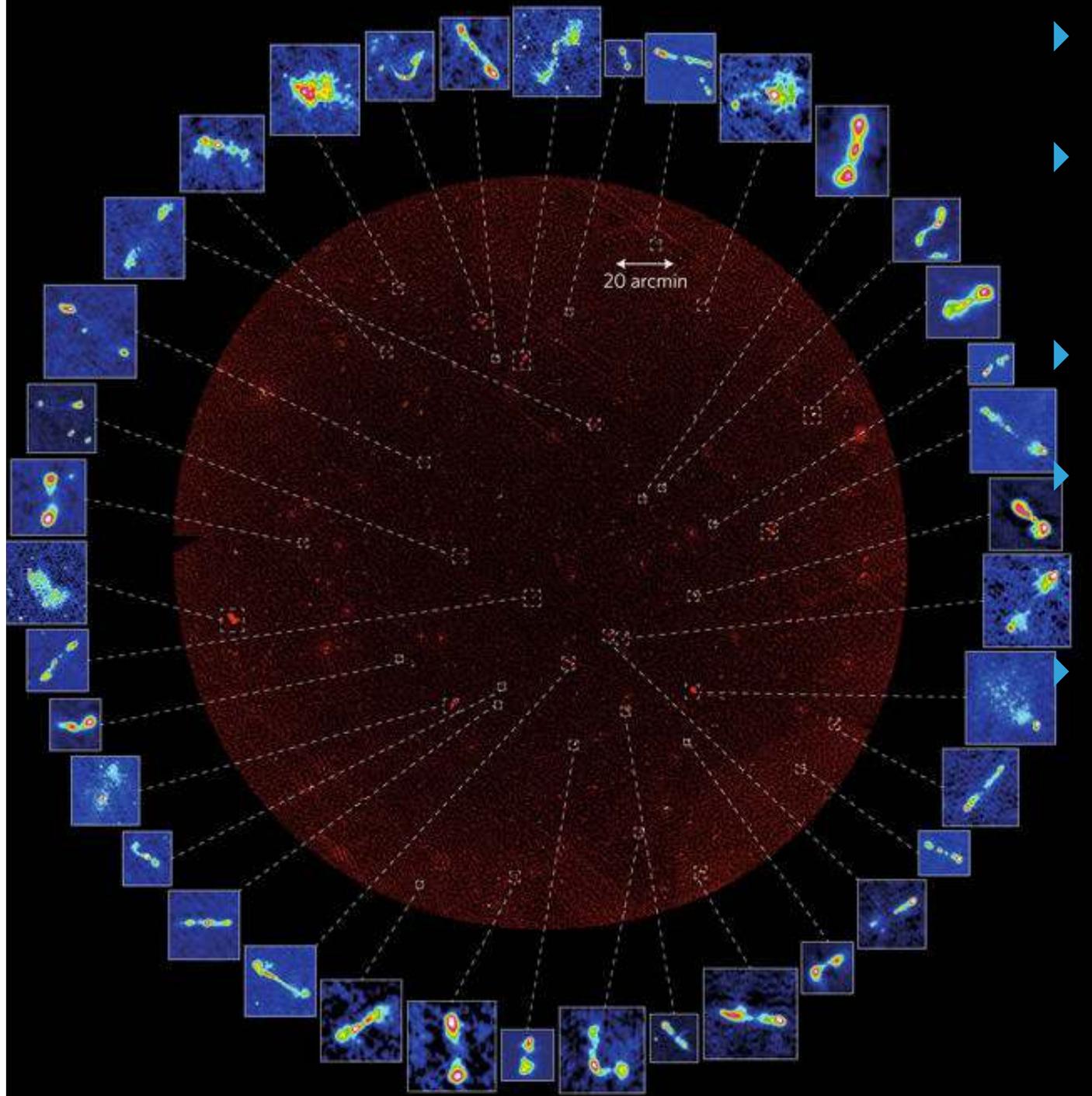
- Radio interference
- Demixing: removal of A-team sources
- Timing of the stations clocks
- Ionosphere (to first order)
- Beam calibration
- Wide-field mapmaking
- Huge data sets
 - fast algorithms
 - Grid enabling
- Source finding
- Characterisation morphologies
- Id'ing
- Photometric redshifts
- Characterisation

The Challenge: the ionosphere



Note: these 150 MHz images have only 3 arcmin resolution, the NL array has 5 arcsec resolution...





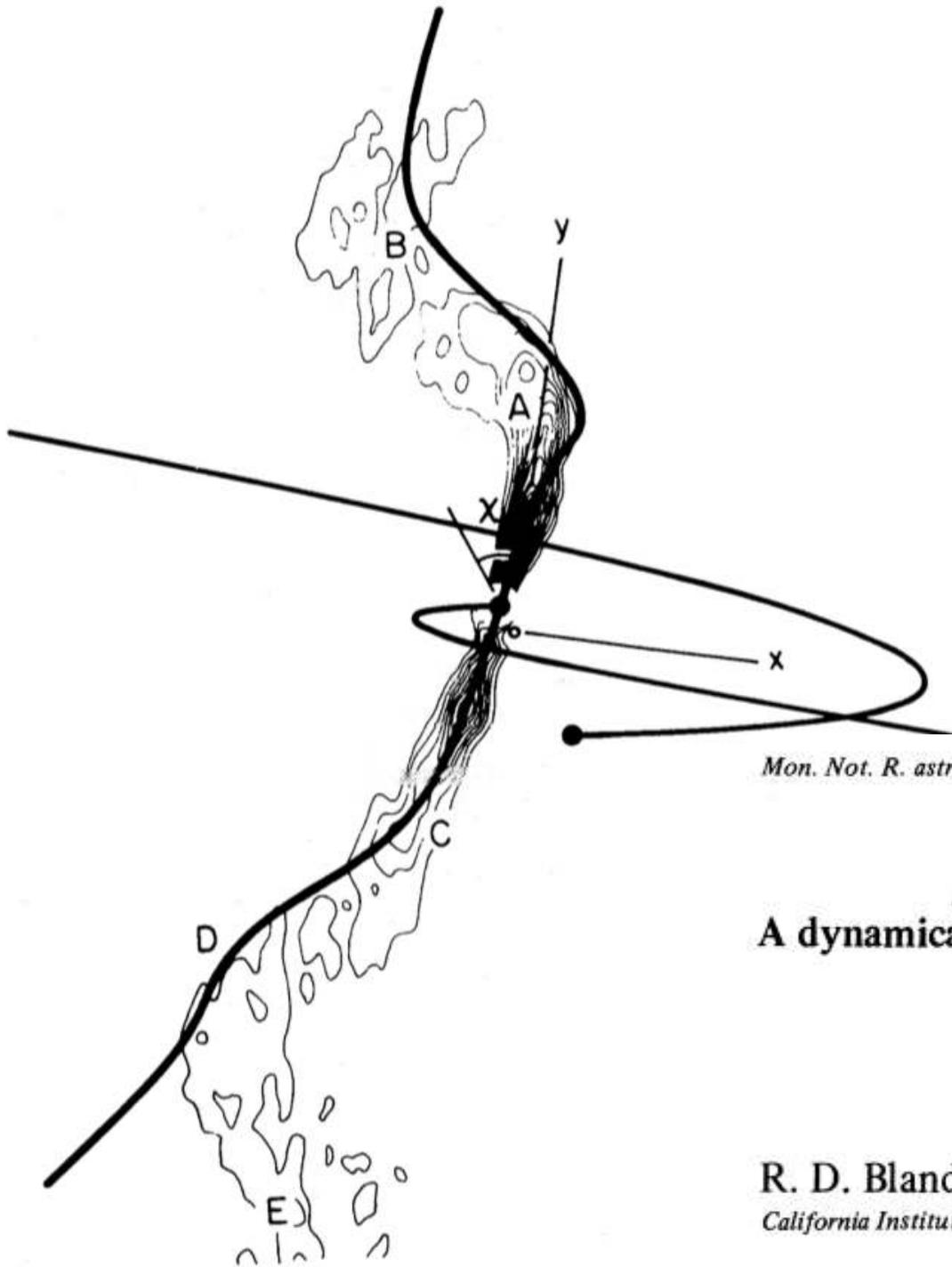
- ▶ 19 sq.deg
- ▶ 120 to 150 $\mu\text{Jy}/\text{beam}$ RMS
- ▶ 6" resolution
- ▶ ~6000 sources in the field
- ▶ ~3300 within the optical region

Months of work!

Williams et al. 2016

**Zooming in on extra-galactic objects
observed by the LOFAR radio telescope**





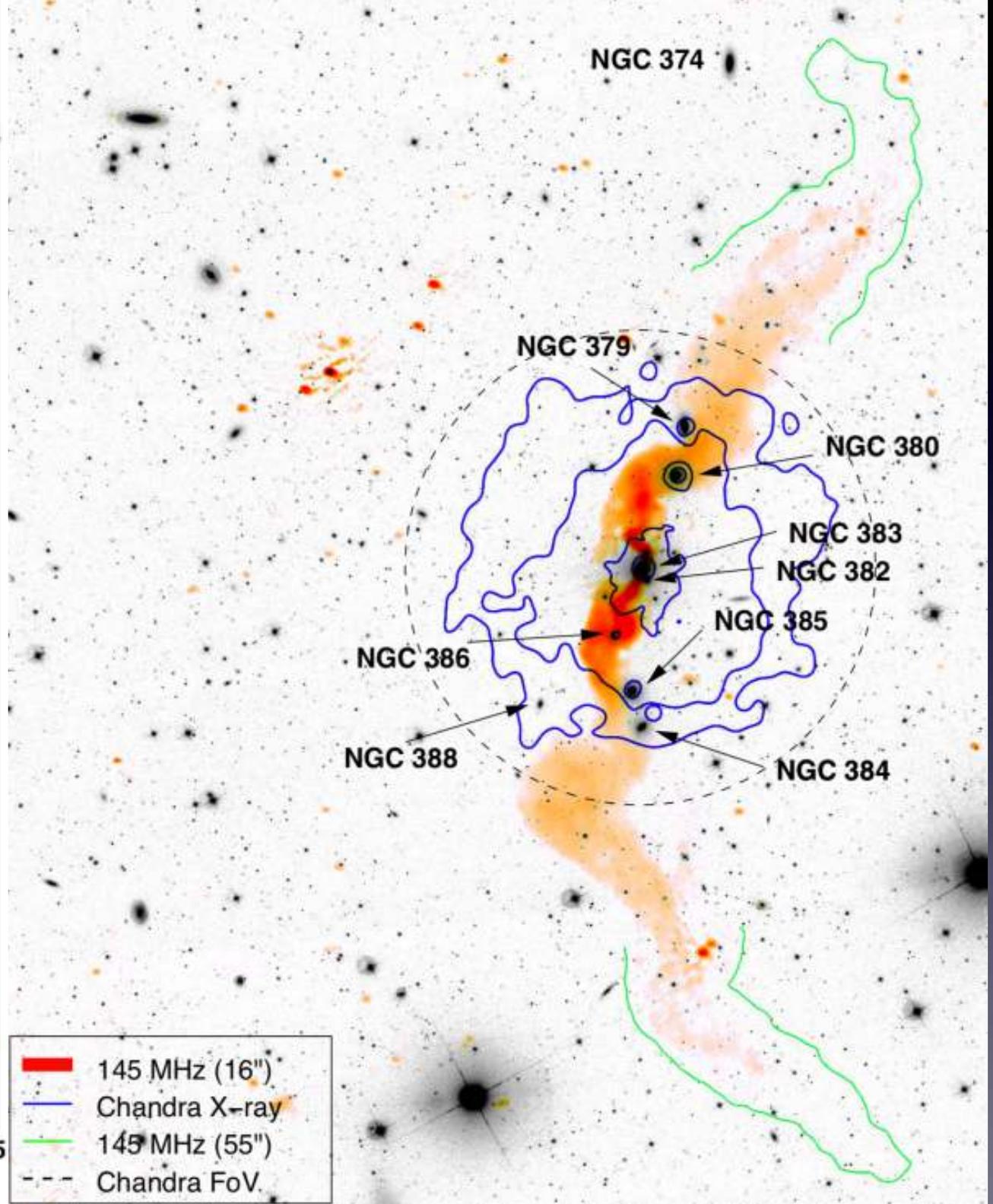
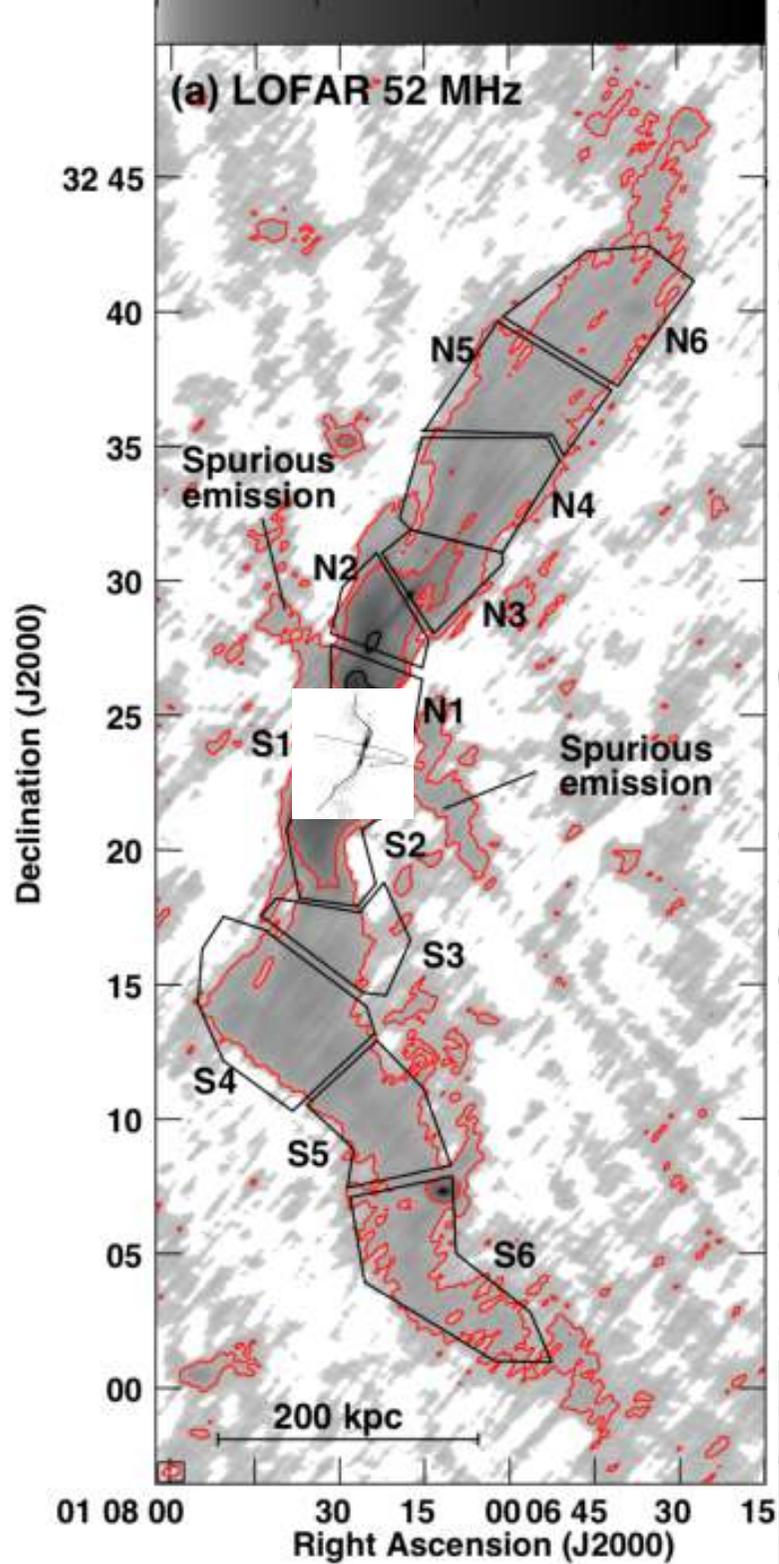
Mon. Not. R. astr. Soc. (1978) 185, 527–538

A dynamical interpretation of the radio jet in 3C 31

R. D. Blandford and V. Icke *w. K. Kellogg Radiation Laboratory,
California Institute of Technology, Pasadena, California 91125, USA*

Received 1978 May 3; in original form 1978 March 28



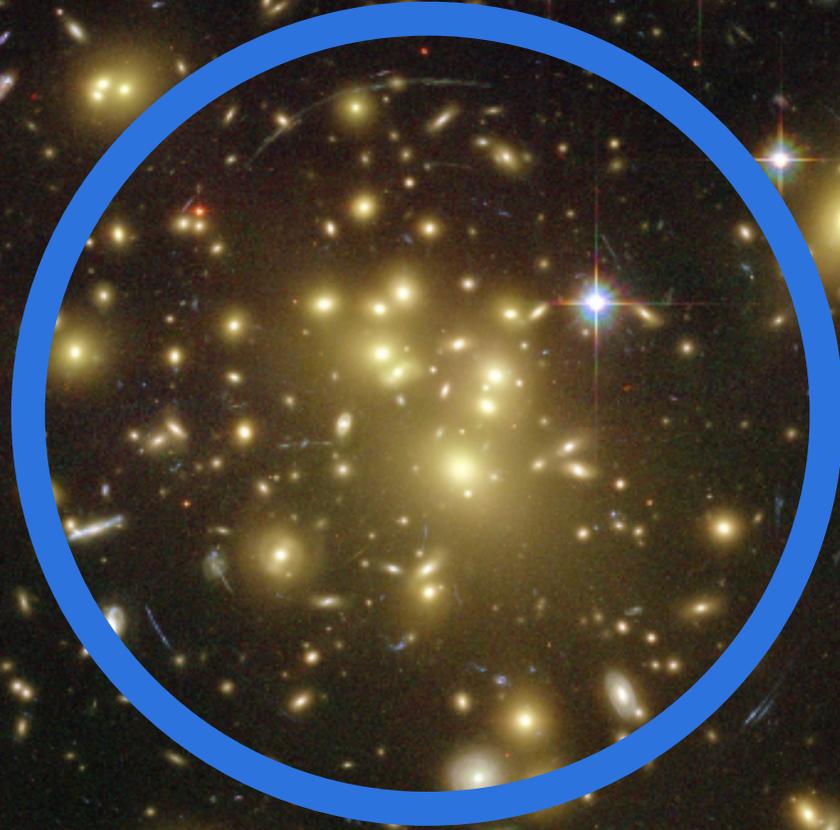


DWDD
21 February 2019

<https://dewerelddraaitdoor.bnnvara.nl/media/684220>

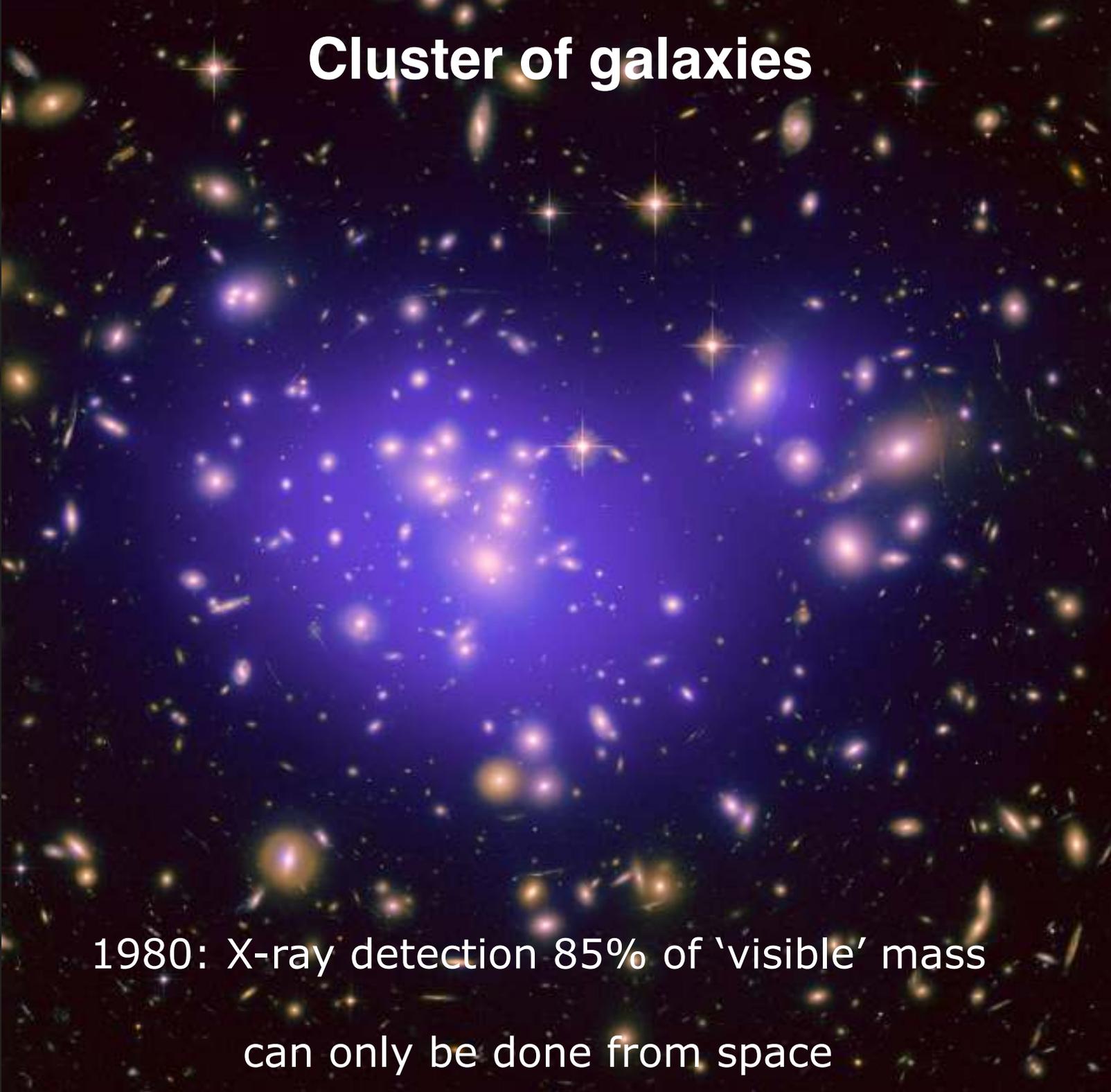


Cluster of galaxies



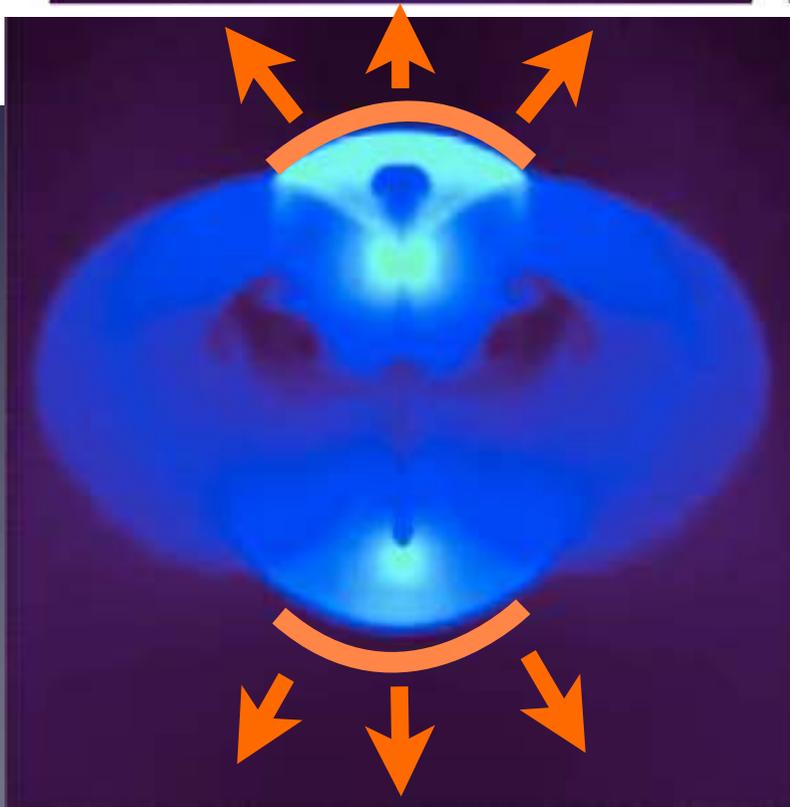
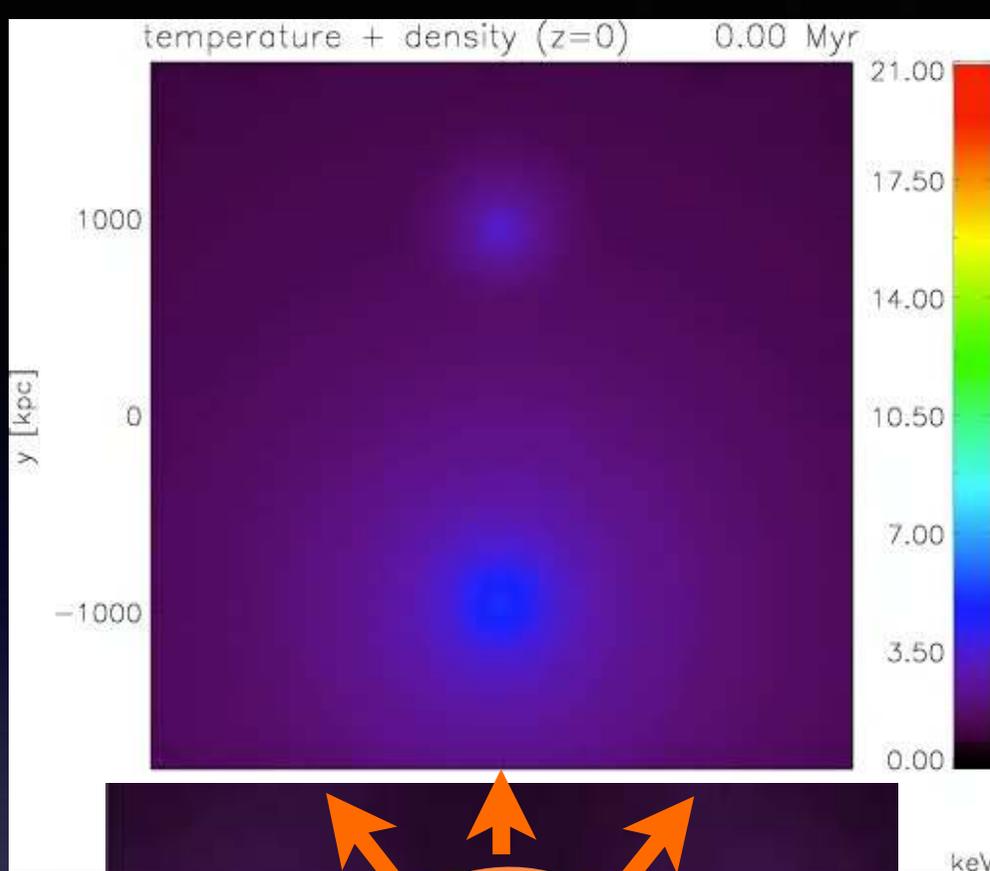
Optical image: 15% of visible mass

Cluster of galaxies

A deep-field image of a galaxy cluster. The background is dark, filled with numerous galaxies of various shapes and sizes, including spirals, ellipticals, and irregulars. A prominent feature is a bright, diffuse blue glow in the center, indicating the presence of a hot intracluster medium. Several bright, point-like sources with diffraction spikes are scattered throughout the field, likely representing individual stars or distant galaxies.

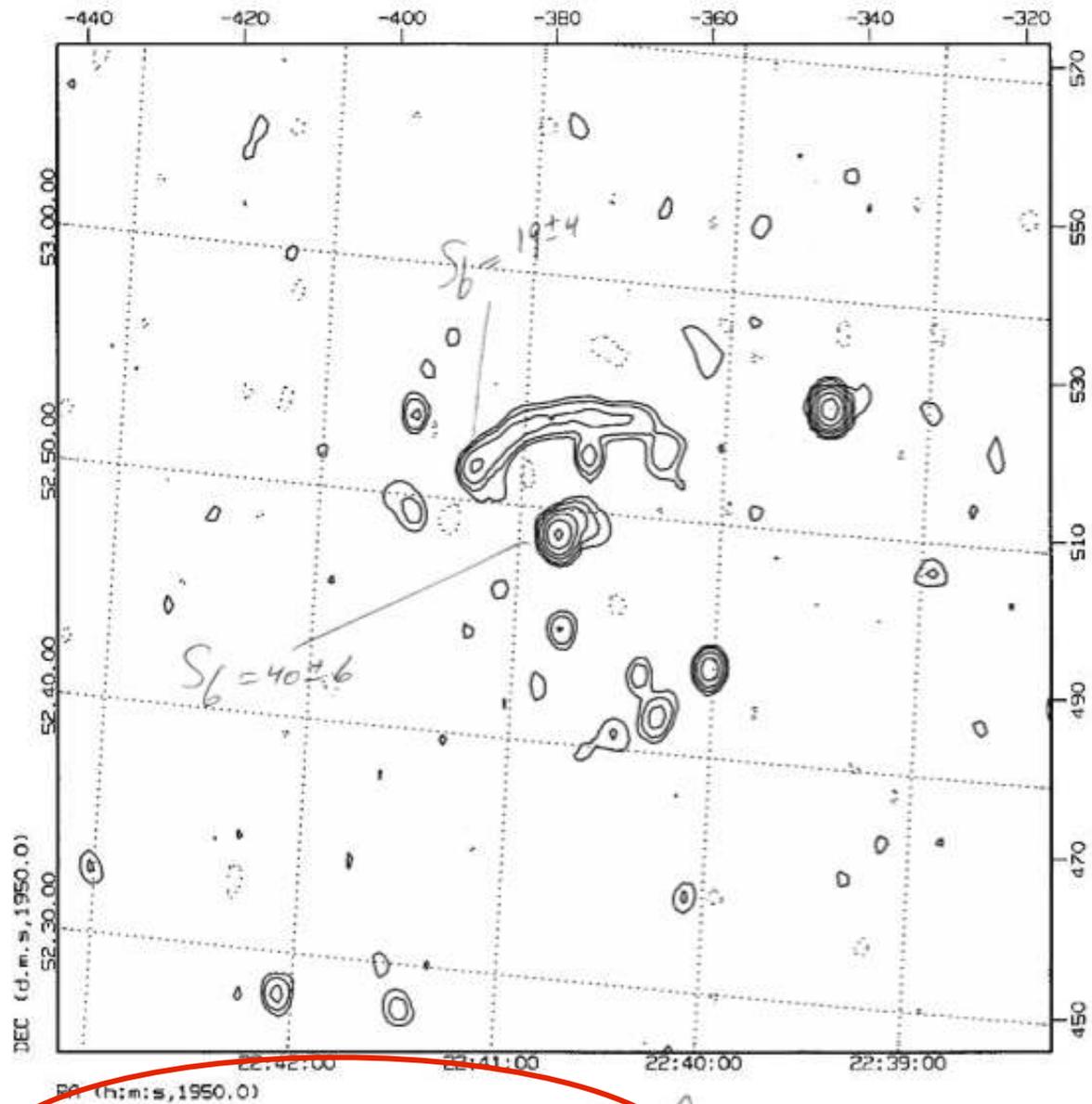
1980: X-ray detection 85% of 'visible' mass
can only be done from space

Simulation X-ray gas of two colliding clusters



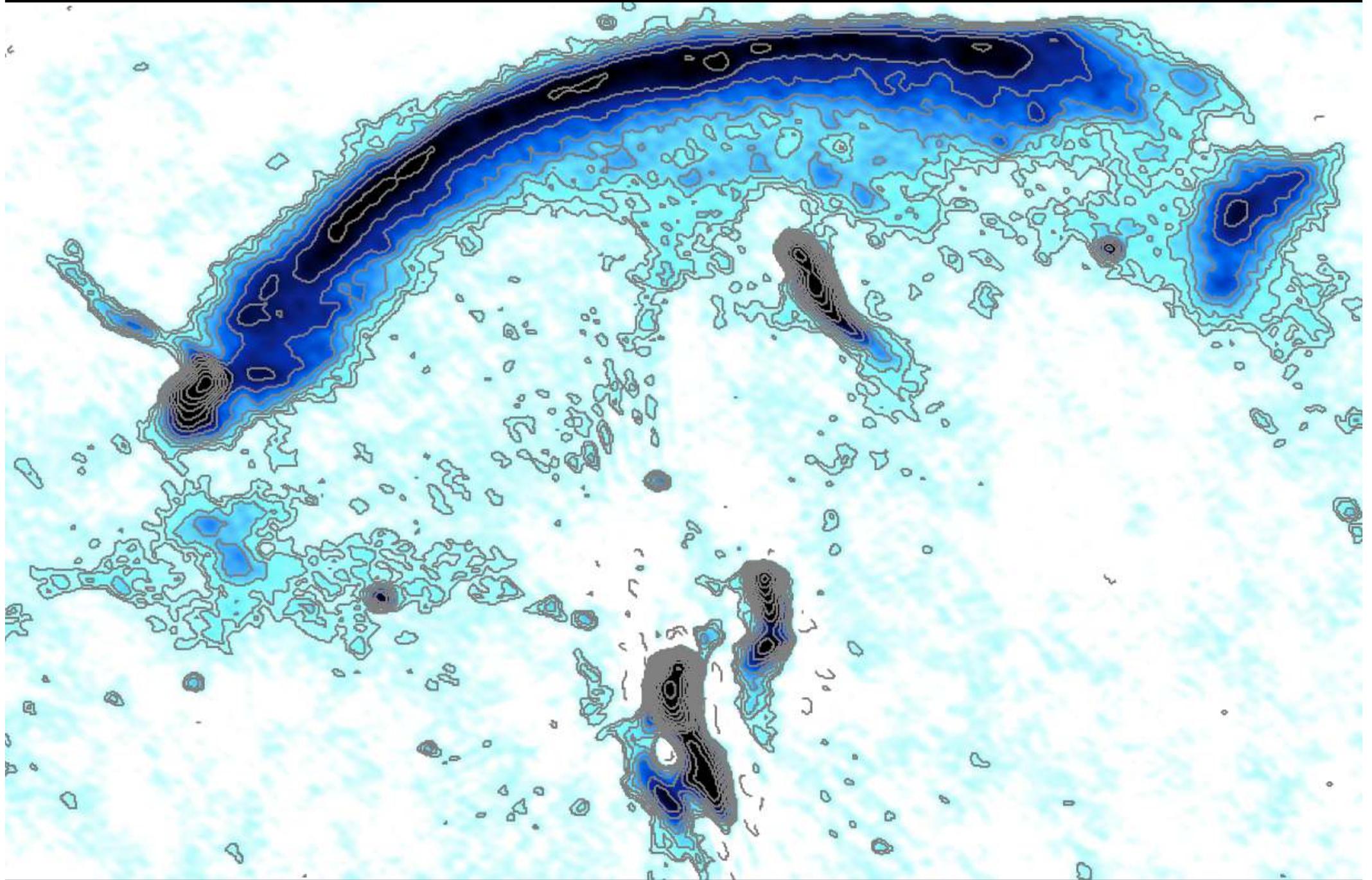
At the shock: particle
acceleration
with a bit of magnetic field
this gives synchrotron
radiation

classification:
relic radio sources

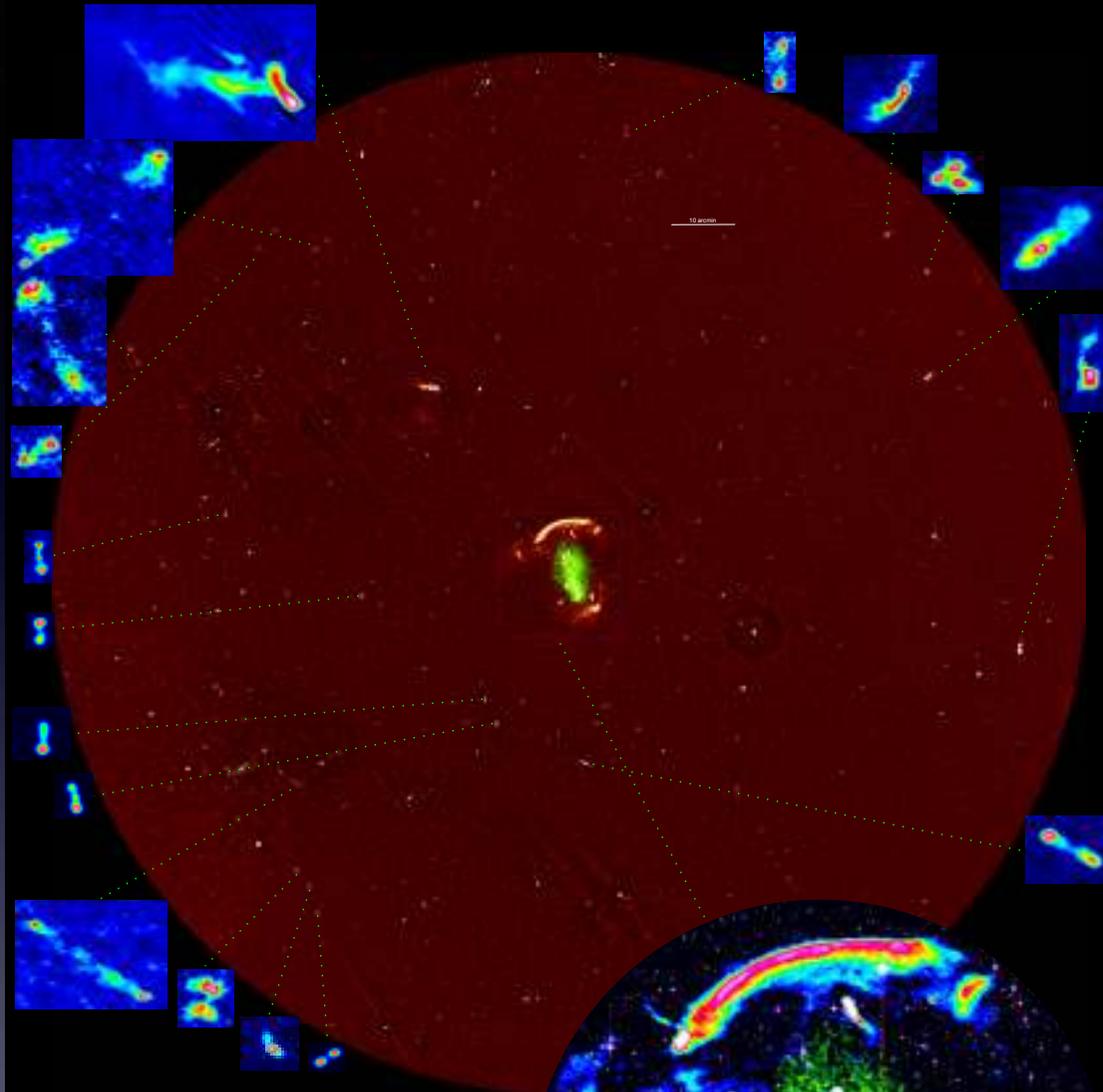


l0' head-tail?



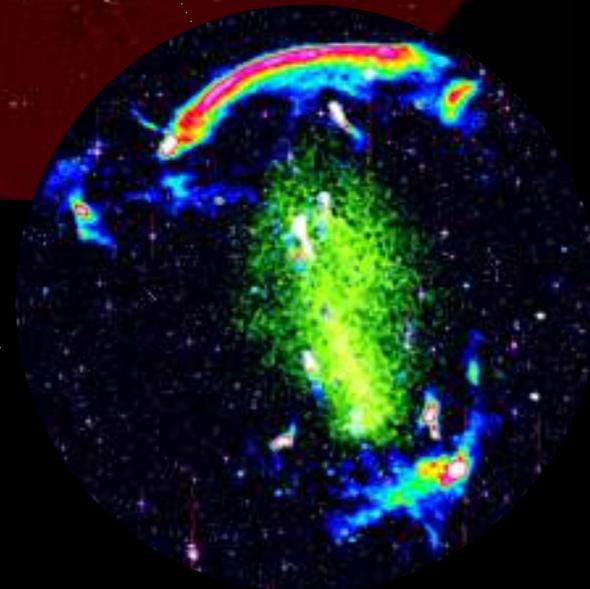


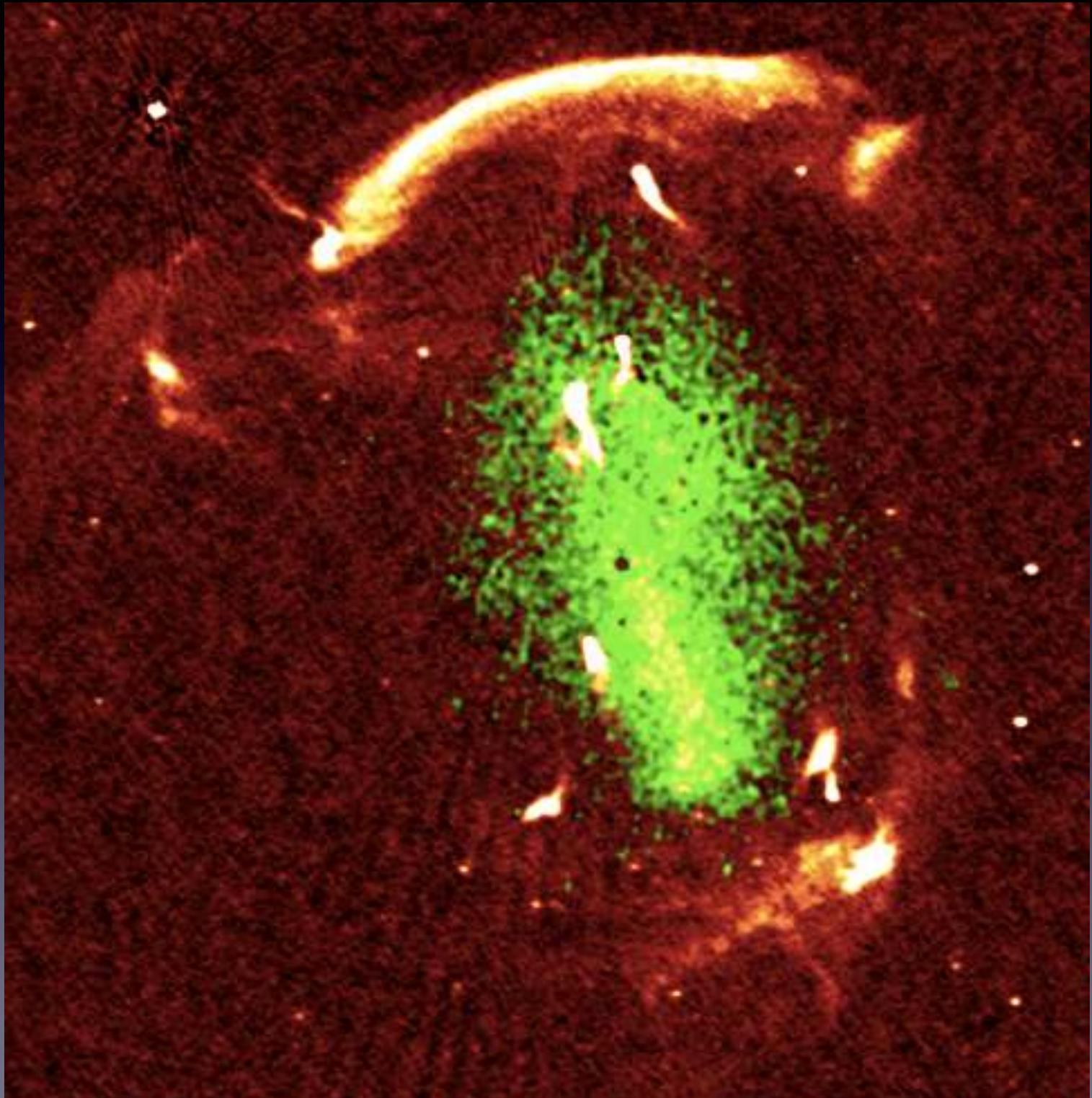
LOFAR @ 150 MHz: the Sausage cluster

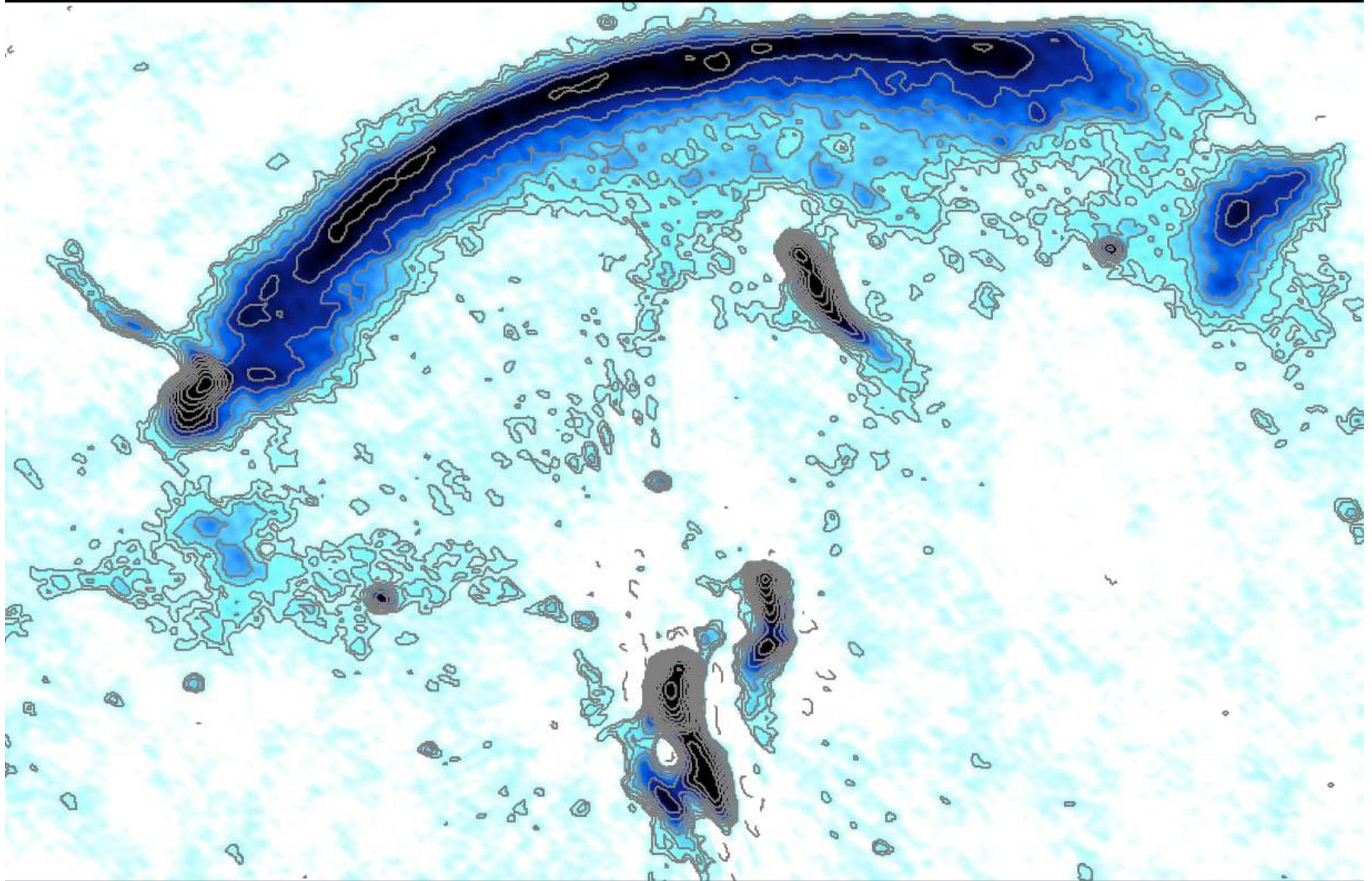


This is the most sensitive image of the Sausage field observed with LOFAR High Band Antennas at 150 MHz. The Sausage cluster shows two opposite giant relics (in rainbow) which were created through galaxy cluster mergers. The collisions also heat up the intra-cluster gas to extreme hot plasma capable of emitting X-ray radiations (*Chandra* data by O'grea et al. 2014 in green). These locations are where cosmic particles (e.g. electrons) are accelerated to extremely high energy. The other resolved sources are mostly radio galaxies hosting an active massive black hole. In the cut-out Sausage image, the optical background (*Subaru* & CFHT data by Dawson et al. 2015) shows light from galaxies and stars.

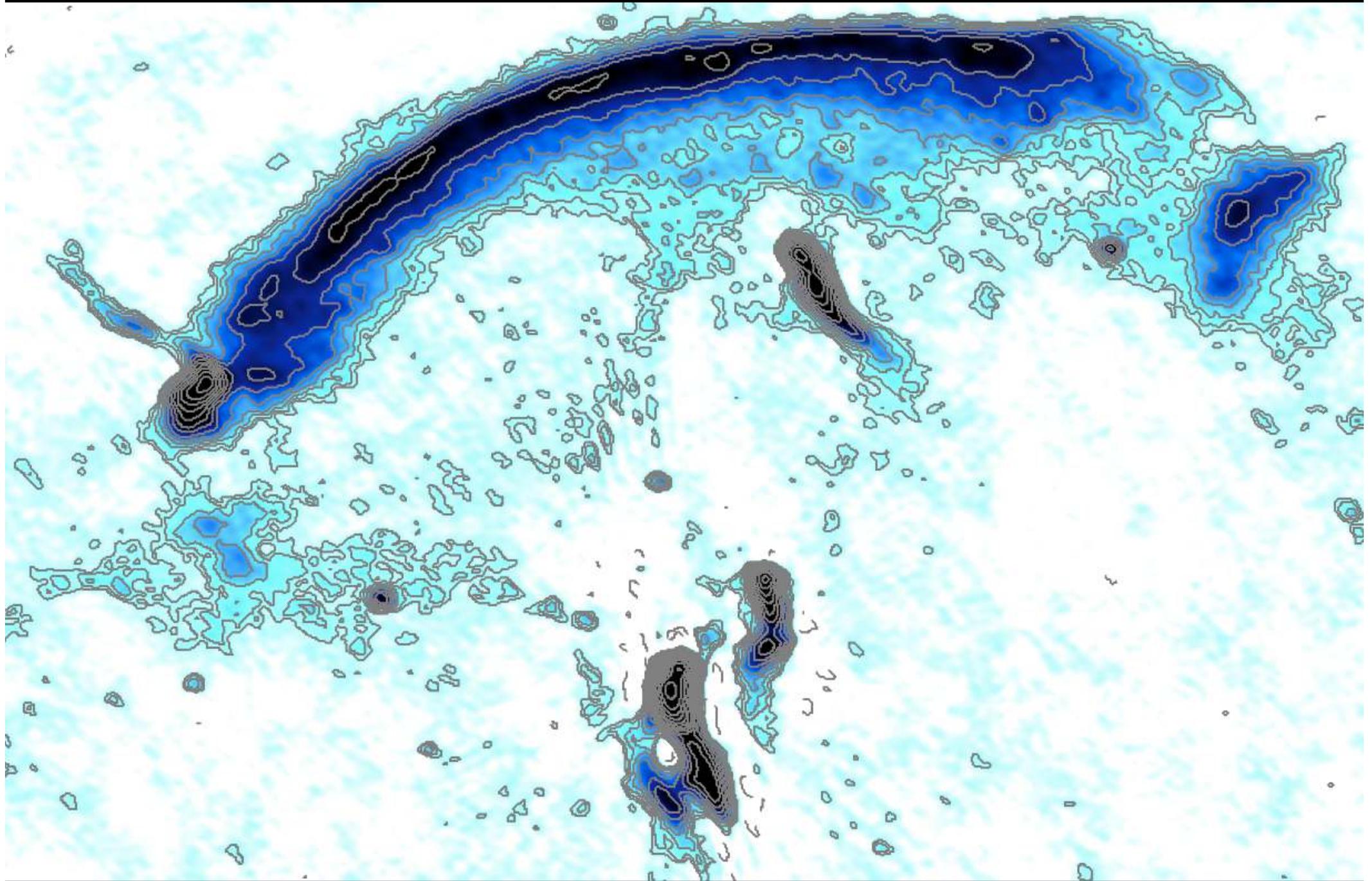
Image credits: Duy Hoang (Leiden), Tim Shimwell (Leiden), Andra Stroe (ESO), Reinout van Weeren (Harvard) and Huub Röttgering (Leiden) for the LOFAR survey team.







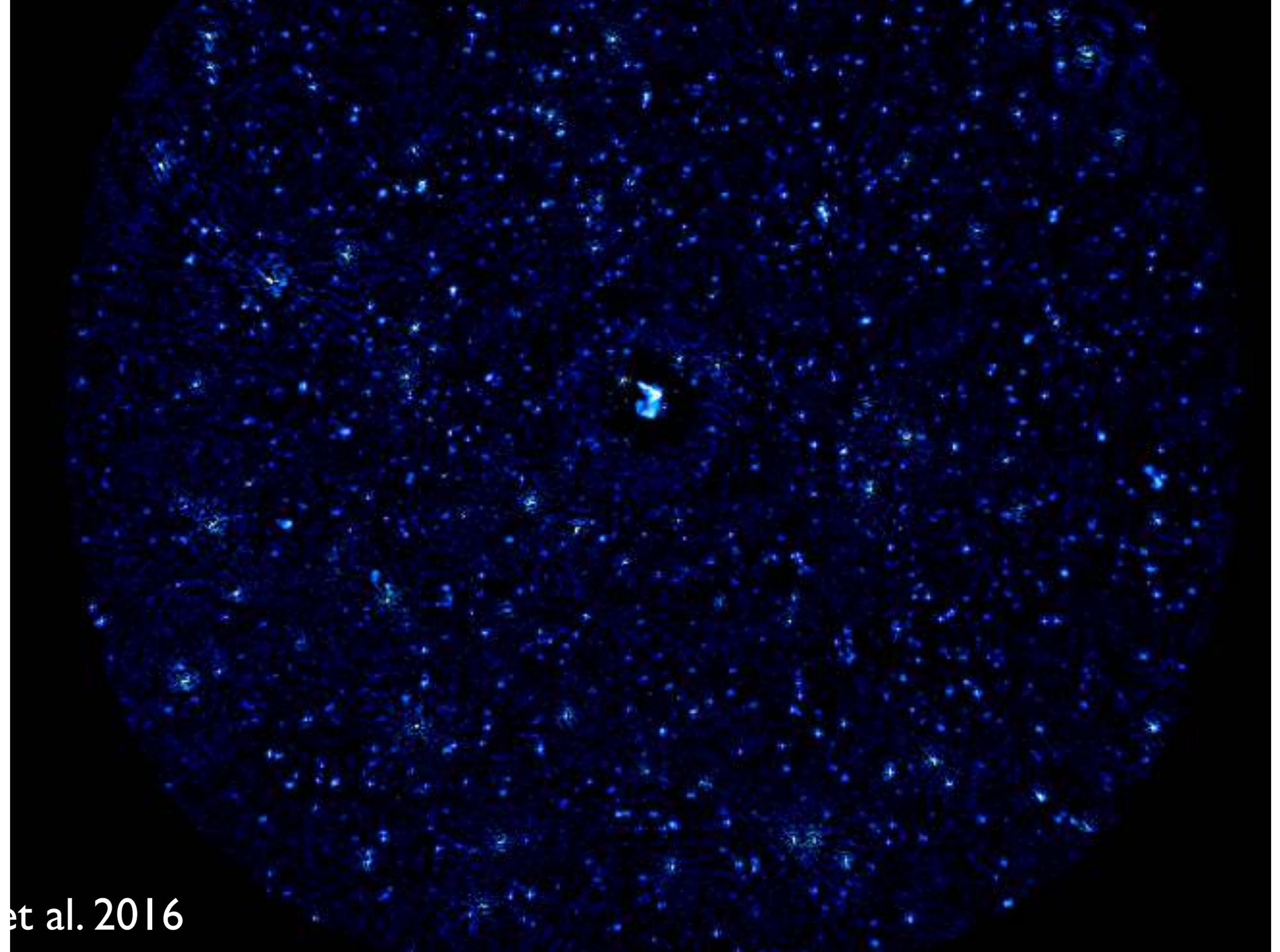
QI



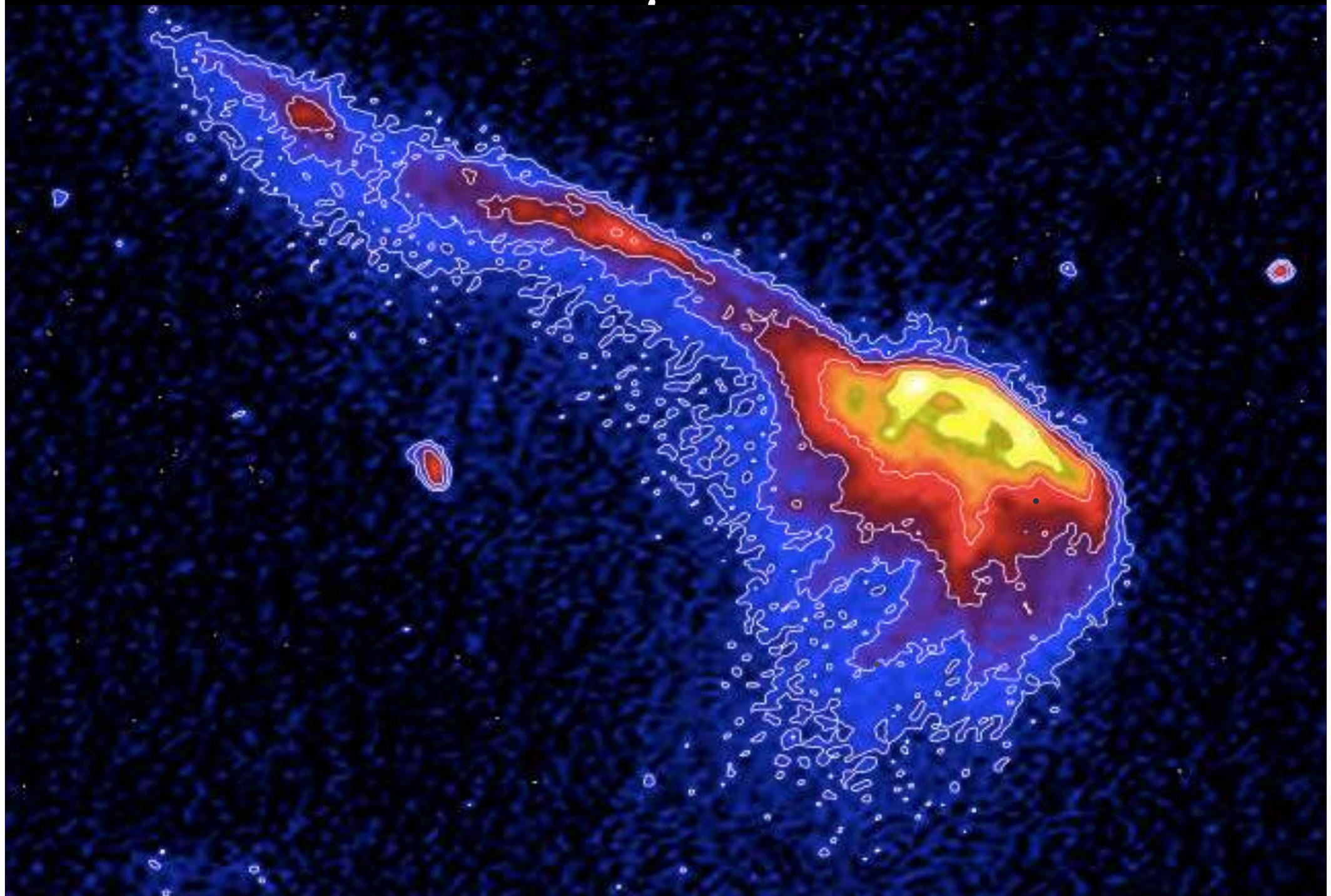


Sausage
cluster

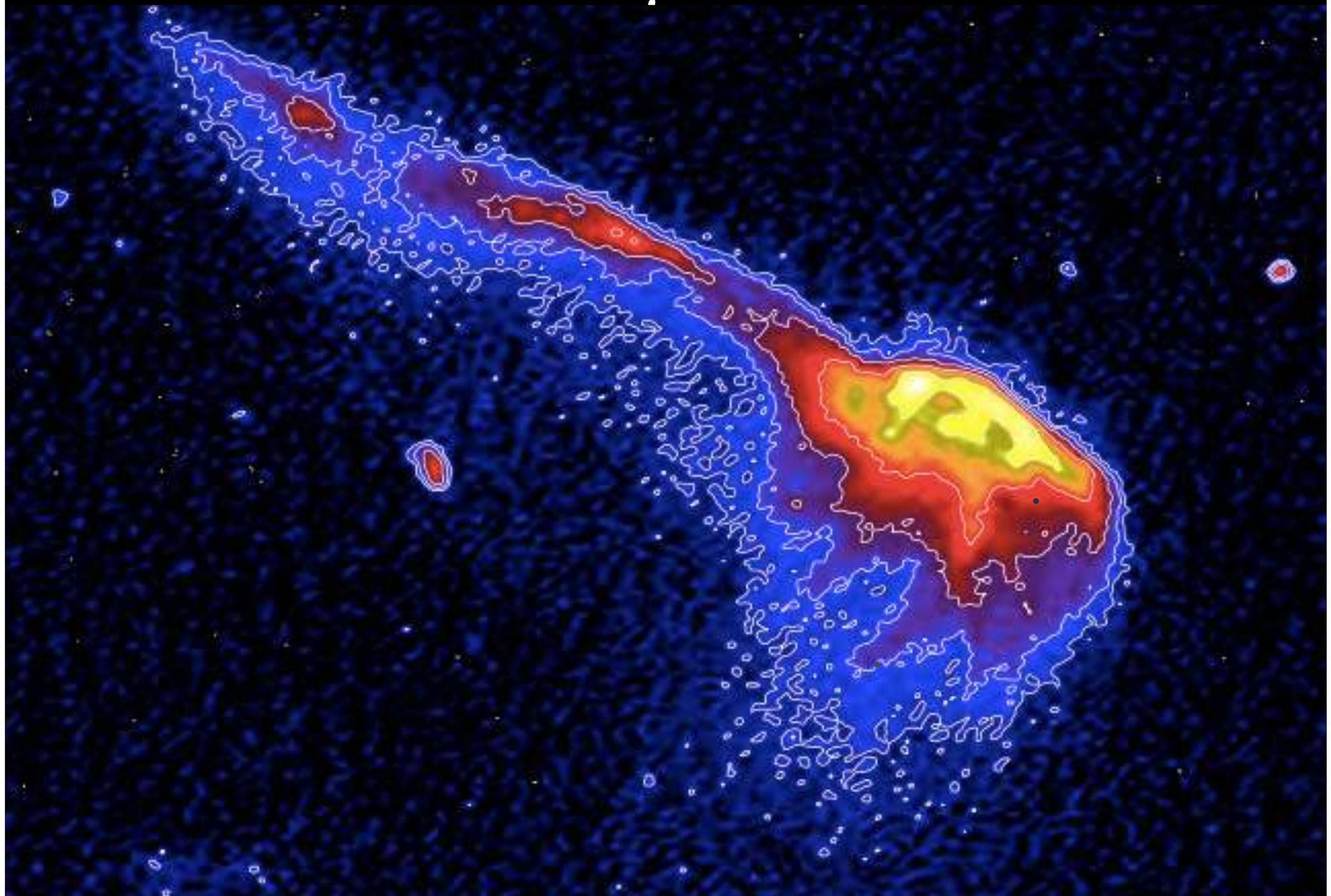
Q2



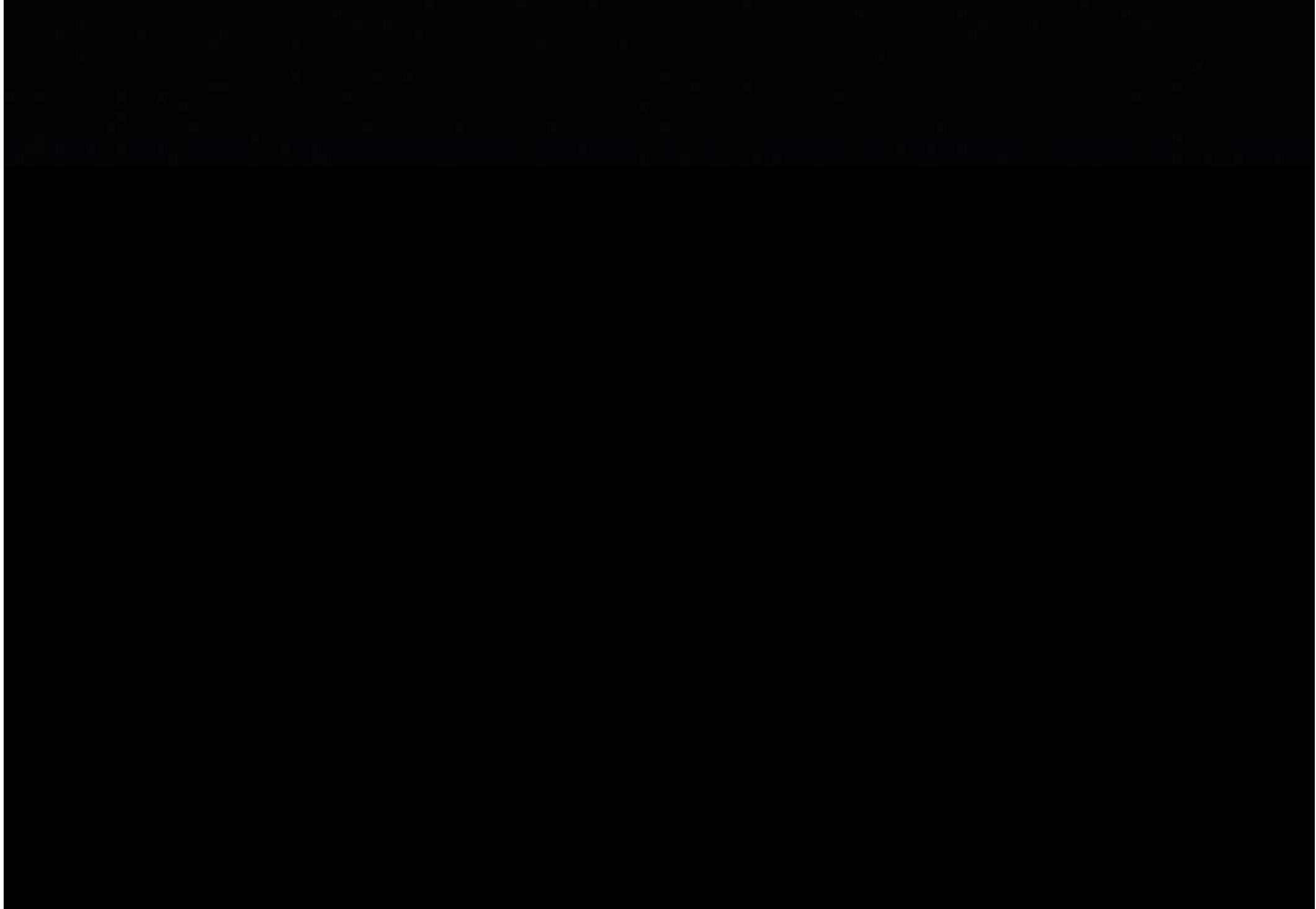
et al. 2016



Q2







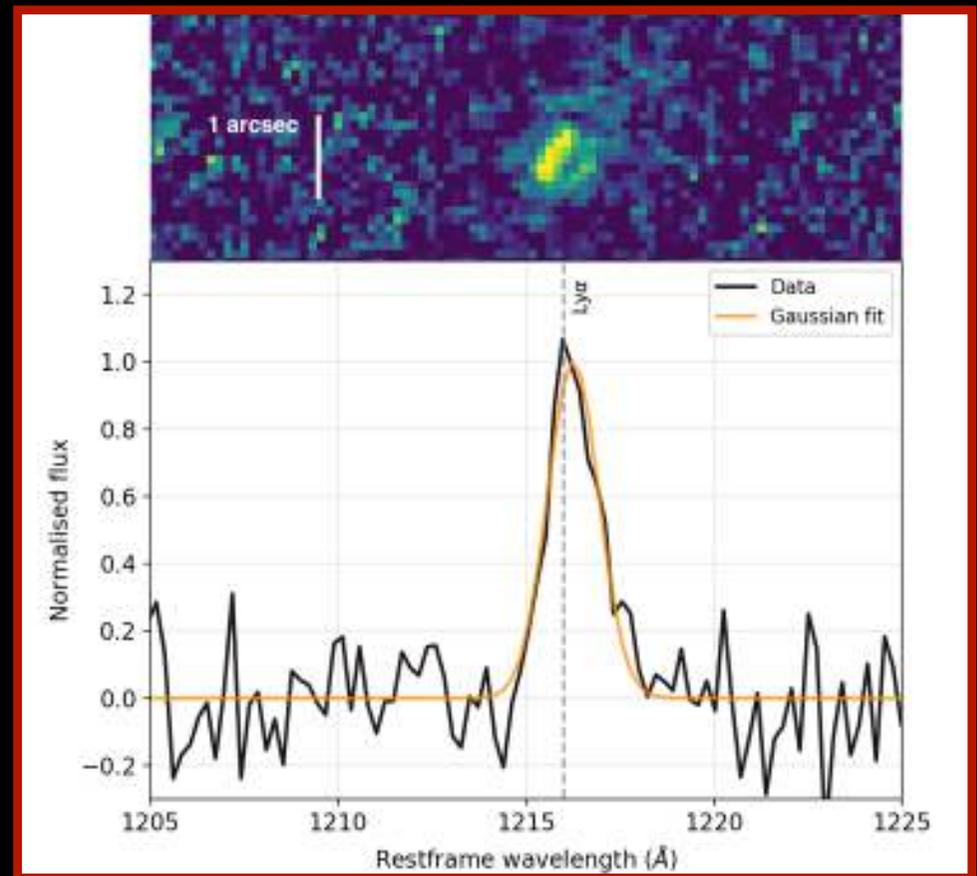
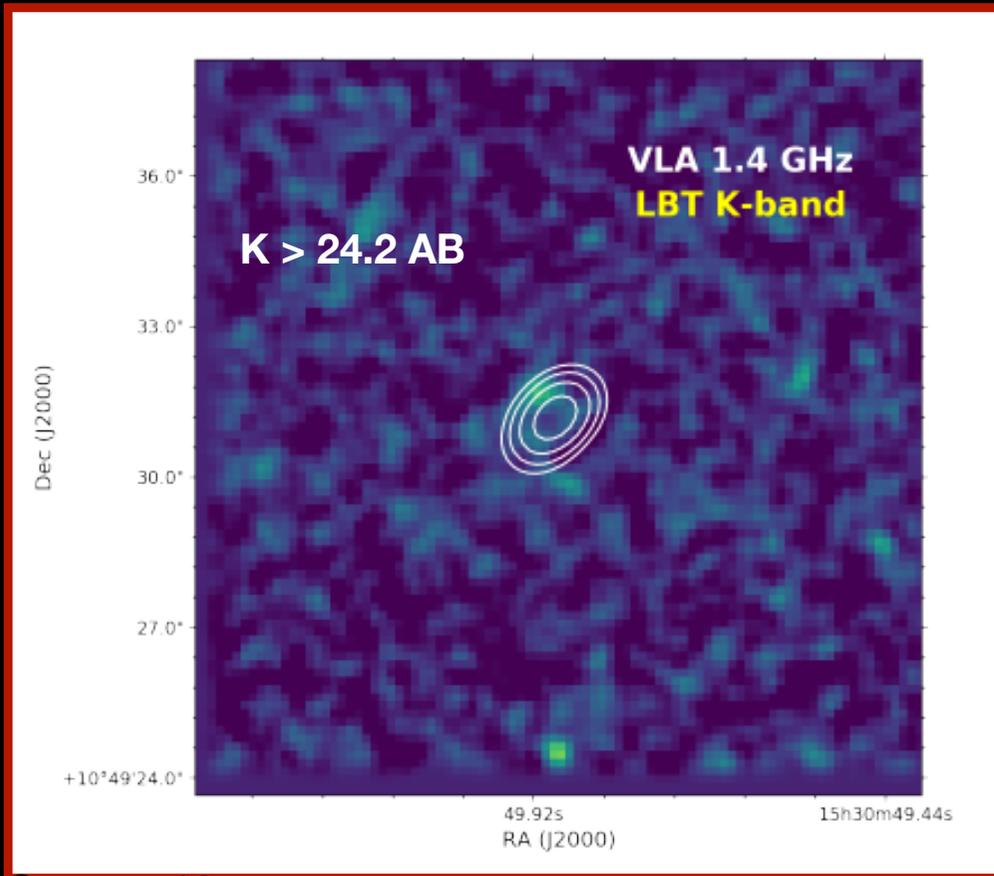
President Trump Downplays Steve Bannon's Campaign Role: 'I'm My Own Strategist'



President Trump congratulates White House strategist Stephen Bannon in Washington, D.C., on Jan. 22, 2017. Mandel Ngan—AFP/Getty Images

Discovery of a radio galaxy at $z = 5.72$

TGSS J1530+1049



TRENDING: [ILHAN OMAR ANTISEMITIC](#) [TRUMP 52% APPROVAL](#) [DENVER TEACHERS STRIKE](#) [GRAMMY](#)

ASTRONOMERS DISCOVER MOST DISTANT RADIO GALAXY

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by [UPI](#) | 8 Aug 2018 |  1

Aug. 8 (UPI) — Astronomers in the Netherlands have identified the most distant radio galaxy ever discovered.

The galaxy, TGSS J1530+1049, is located 12 billion light-years away. The record-setting radio signal hailed from a still infant universe — a time just 840 million years after the Big Bang.