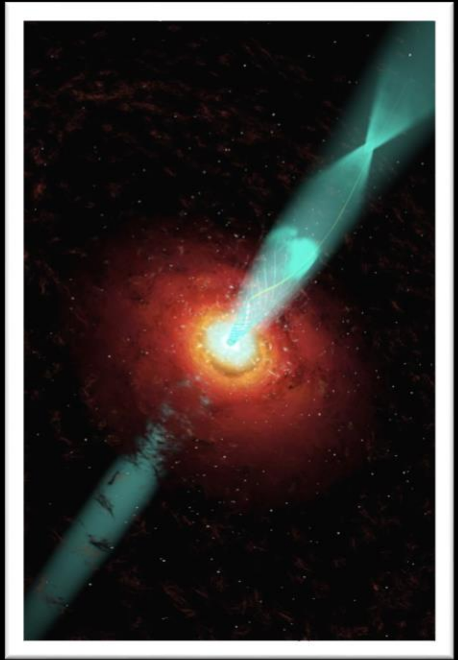
# *Arecibo Observatory Radio Data Crucial for Understanding why Quasars are so Bright*



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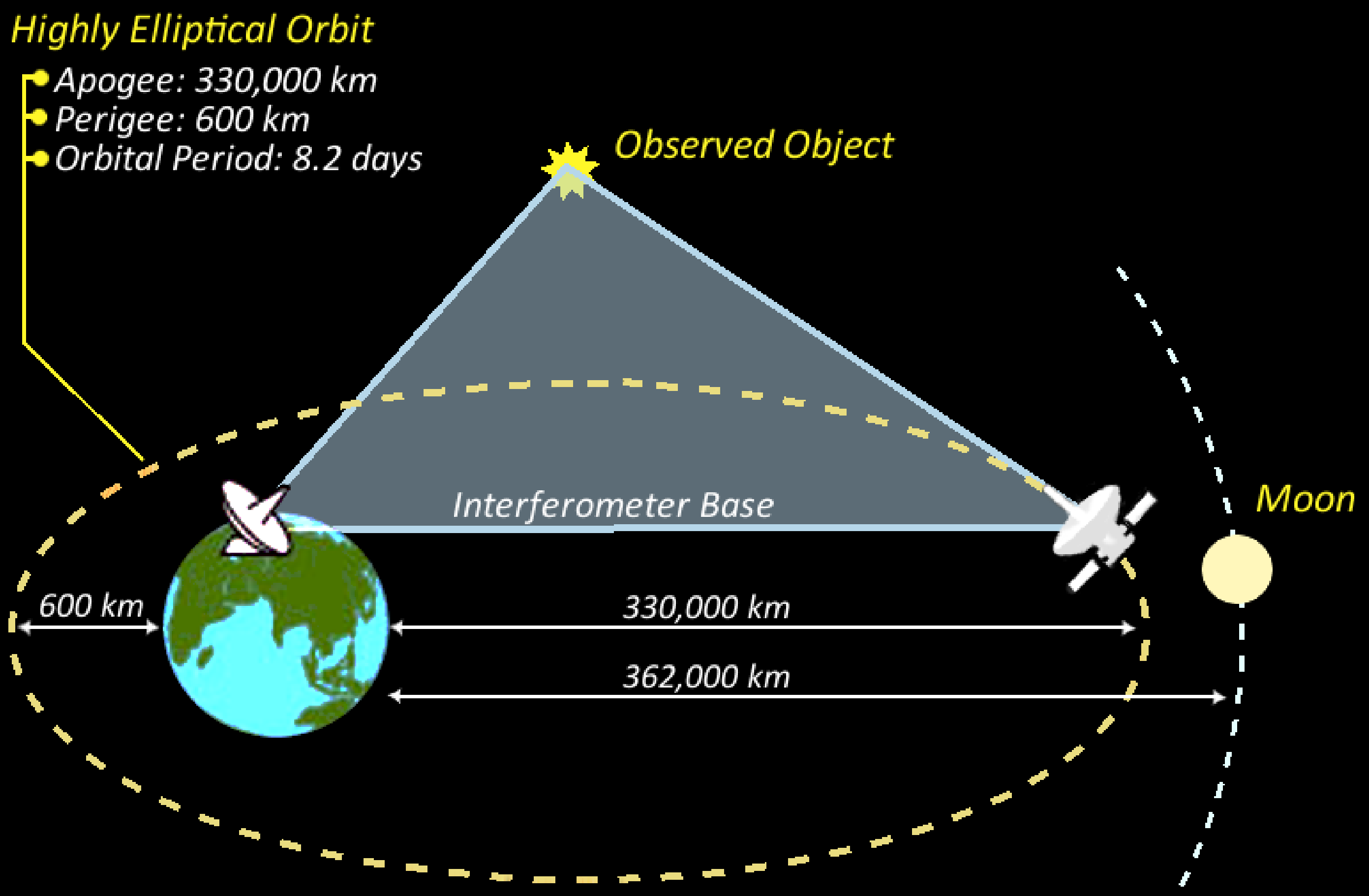
# The RadioAstron Orbital Telescope

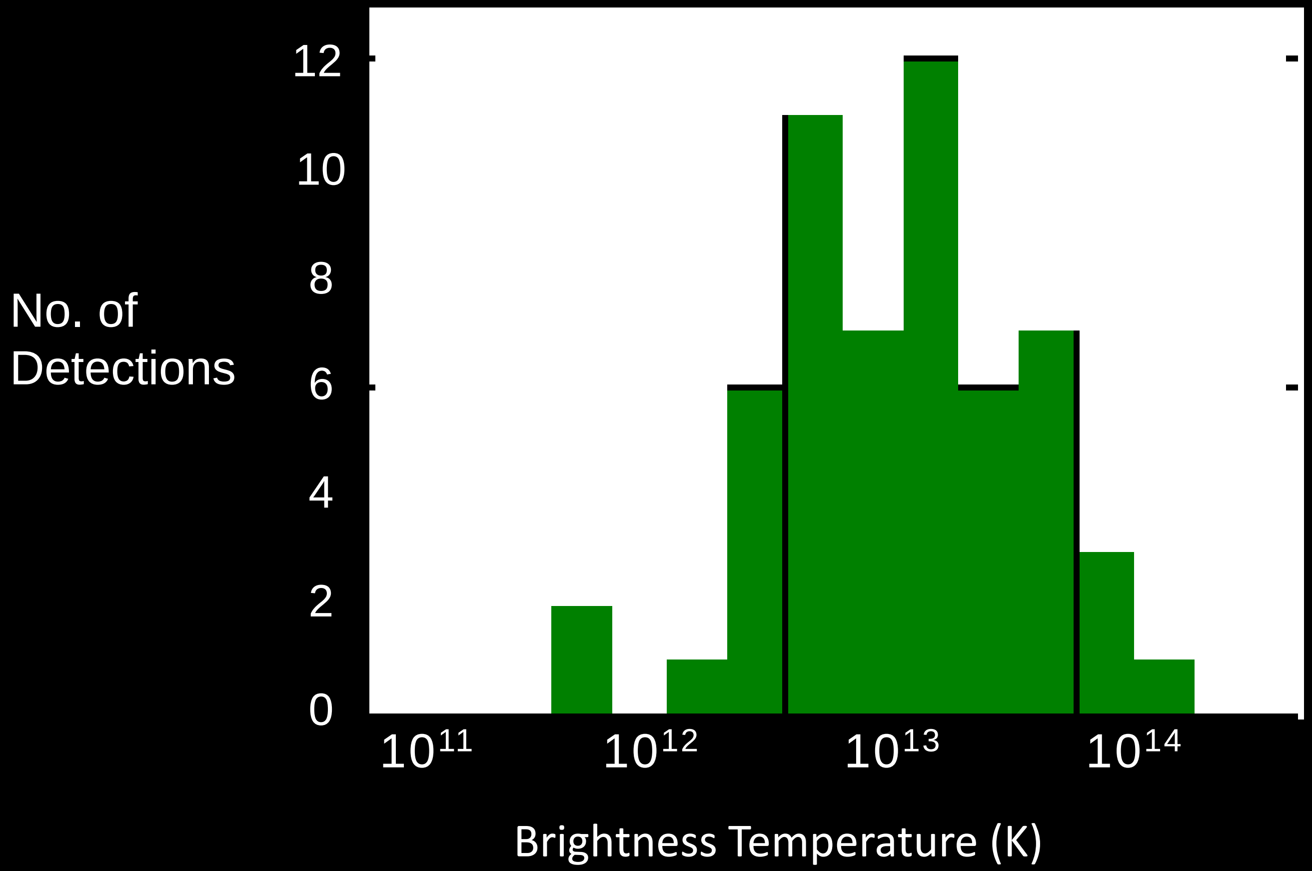



RadioAstron (Diameter = 10 m) needs the collaboration of Arecibo (Diameter = 305 m) to achieve the highest possible sensitivity.

# The “Compton Catastrophe”

- Radio interferometry measures the brightness temperature of a compact radio source. The longer the baseline, the higher the temperature that can be measured.
- Space VLBI provides the longest possible baselines.
- The relativistic electrons in a radio source core are cooled by “Compton scattering” the radio photons to X- or γ-ray energies. This is known as the “Compton Catastrophe”.
- If the electrons have effective temperatures greater than $10^{11}$ – $10^{12}$ K, then they will be cooled to these temperatures in less than a day setting a maximum temperature for the electrons.

# Ultracompact Sources Detected by RadioAstron + Ground Radio Telescopes




Brightness Temperatures are found up to $10^{14}$ K between RadioAstron and Arecibo.

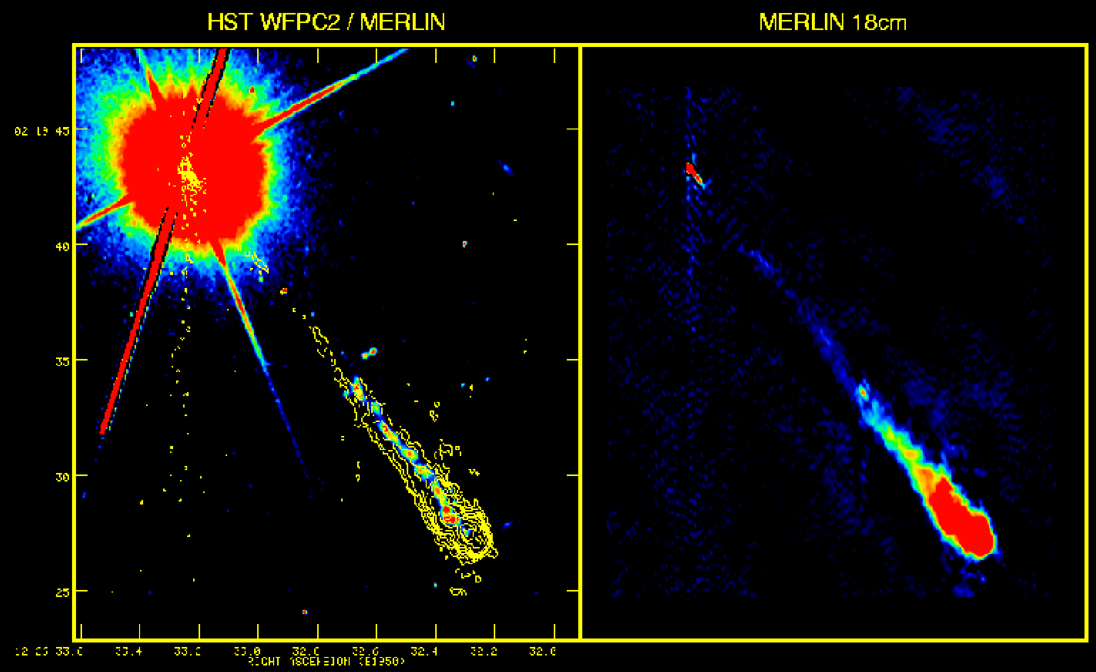
# Case Study: The Quasar – 3C273

1) First quasar identified

2) Located at the center of a giant elliptical galaxy

3) One of the closest quasars

4) Thought to contain a central 1 billion solar mass black hole




5) 3C273 shows a jet of length 200,000 light years

6) RadioAstron-Arecibo reveals a 42 × $10^{12}$ K brightness temperature.

(Kovalev, Y.Y., *et al*. 2016, Ap. J. Lett., 820, L9)

# What do these High Brightness Temperatures Imply?

- Brightness Temperatures ($T_B$) are up to 100 times the predicted limit for relativistic electrons radiating synchrotron emission.
- VLBI kinematic studies show no evidence that Doppler boosting explains the mystery.
- Scenarios such as synchrotron-emitting protons or coherent emission are also probably ruled ruled out by $T_B = 10^{14}$ K.

# The Future?

- RadioAstron – Arecibo observations continue.
- To date the highest measured $T_B$ is about $10^{14}$ K. However, $T_B$'s up to $10^{15}$ K-plus could be measured. Will they be?