

A?

Aalto University
School of Electrical
Engineering

Space research at the Metsähovi Radio Observatory

Joni Tammi, Aalto University Metsähovi Radio Observatory

Metsähovi Radio Observatory

Astronomy *meets*
Engineering *and*
Space exploration



Aalto University
School of Electrical
Engineering

Metsähovi Radio Observatory

Users and personnel from
Aalto Schools and departments
Other universities
Finnish Centre for
Astronomy with ESO
National Land Survey
ReSoLVE Centre of Excellence



Active
galaxies

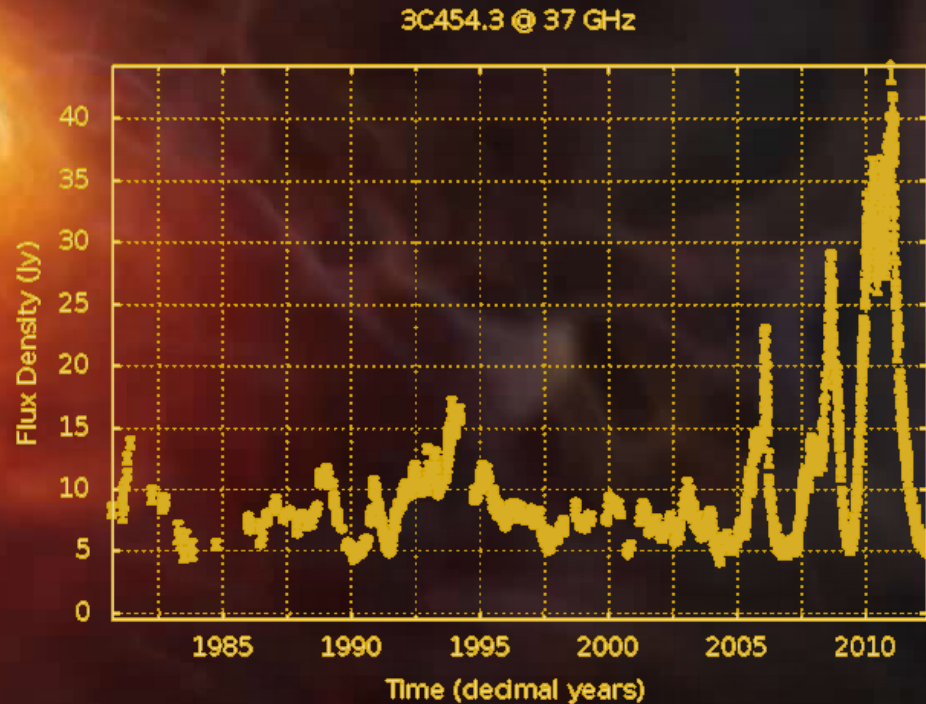
Solar
activity

Spacecraft
observations

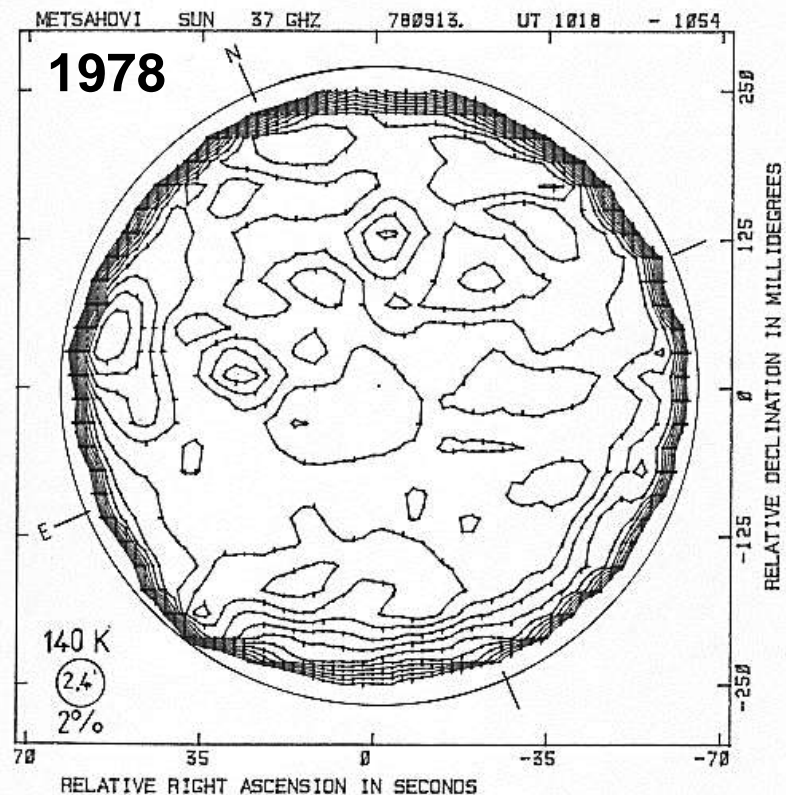
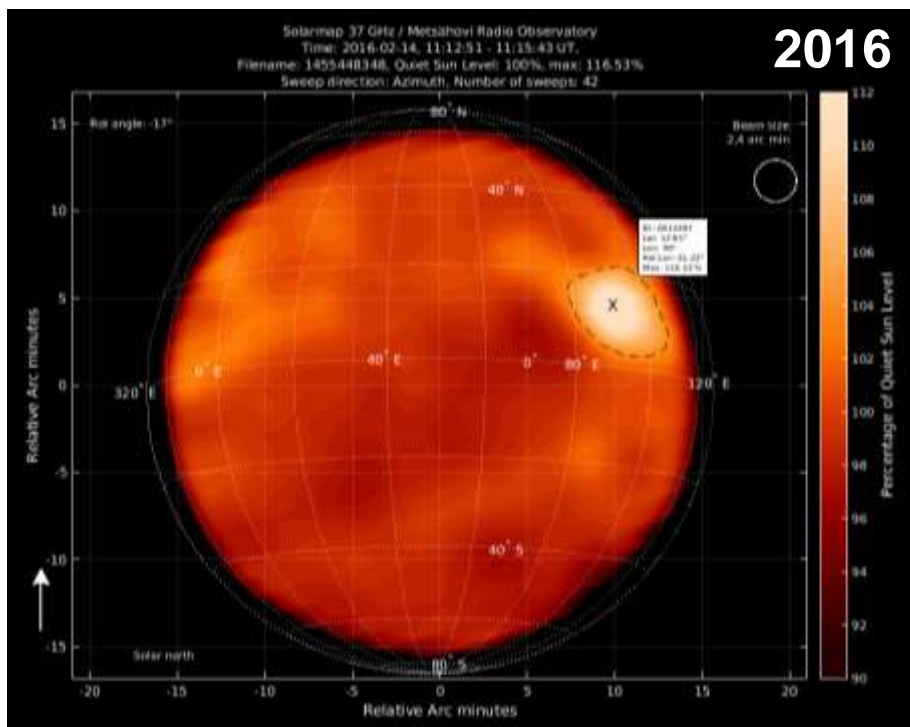
long timeseries



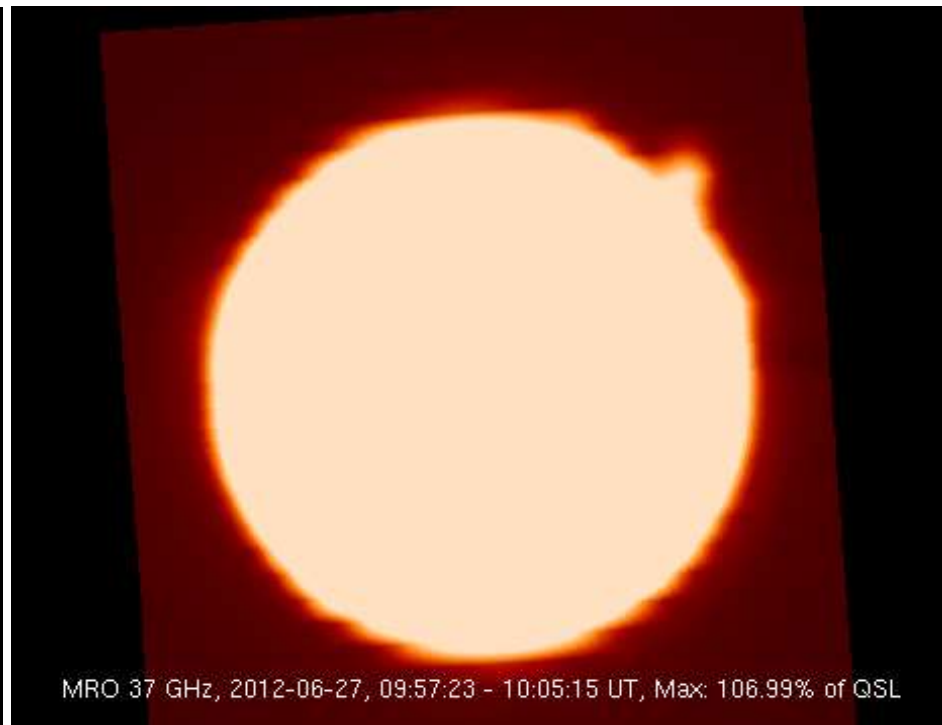
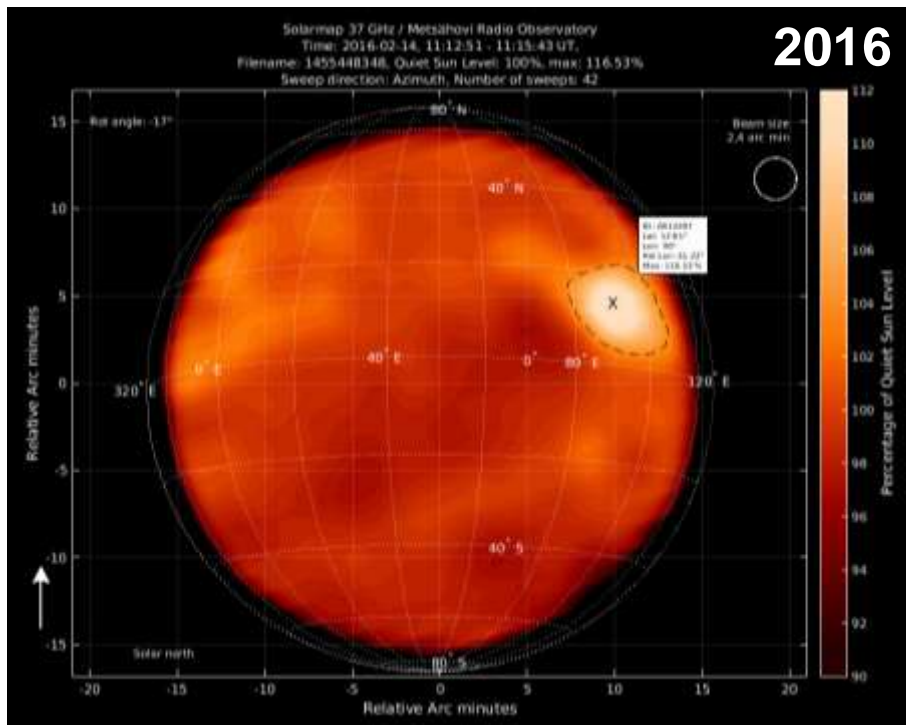
Active galaxy
with giant
plasma jets
ejected by a
*supermassive
black hole*
almost at the
speed of light.



Solar radio mapping for almost 40 years

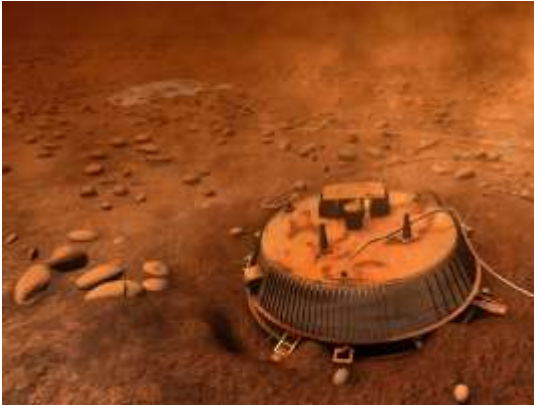


Solar radio mapping for almost 40 years

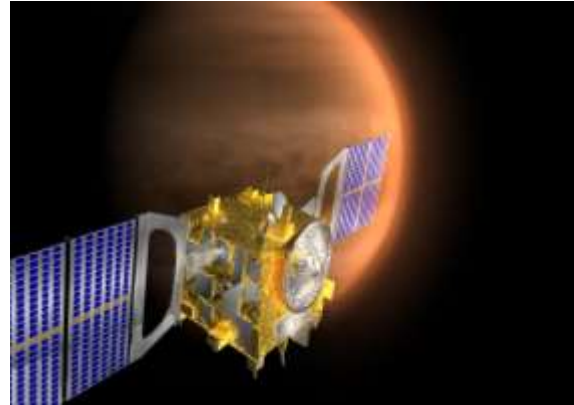


Spacecraft observations

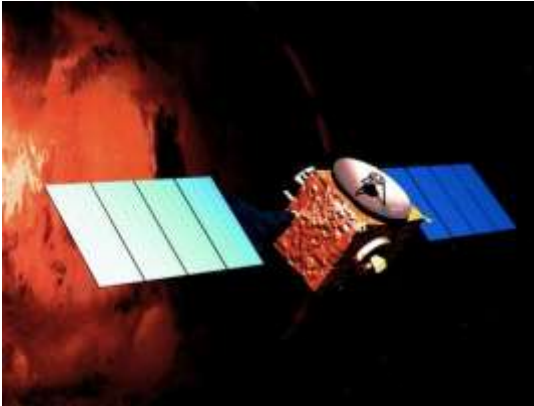
Huygens (NASA/ESA)



Venus Express (ESA)



GLONASS (Russia)



Mars Express (ESA)



Rosetta (ESA)



RadioAston (ASC / RAS)



Active
galaxies

Solar
activity

Spacecraft
observations

Geodesy

Instrumentation

Technical
development

Very-Long
Baseline
Interferometry



Space activities at Metsähovi

Examples

Past: *Planck*

Present: *RadioAstron*

Future: *JUICE*

Past: Planck

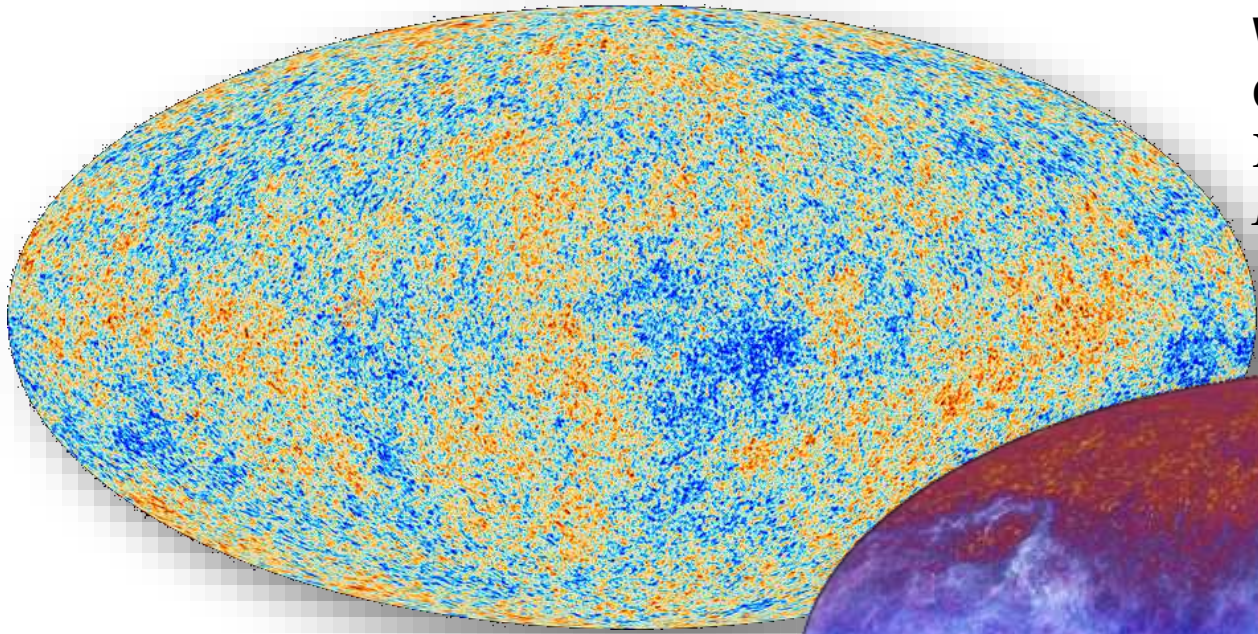
Microwave Space Observatory

- European Space Agency
- Flight: 2009–2013
- Cosmic Microwave Background

Metsähovi / Aalto

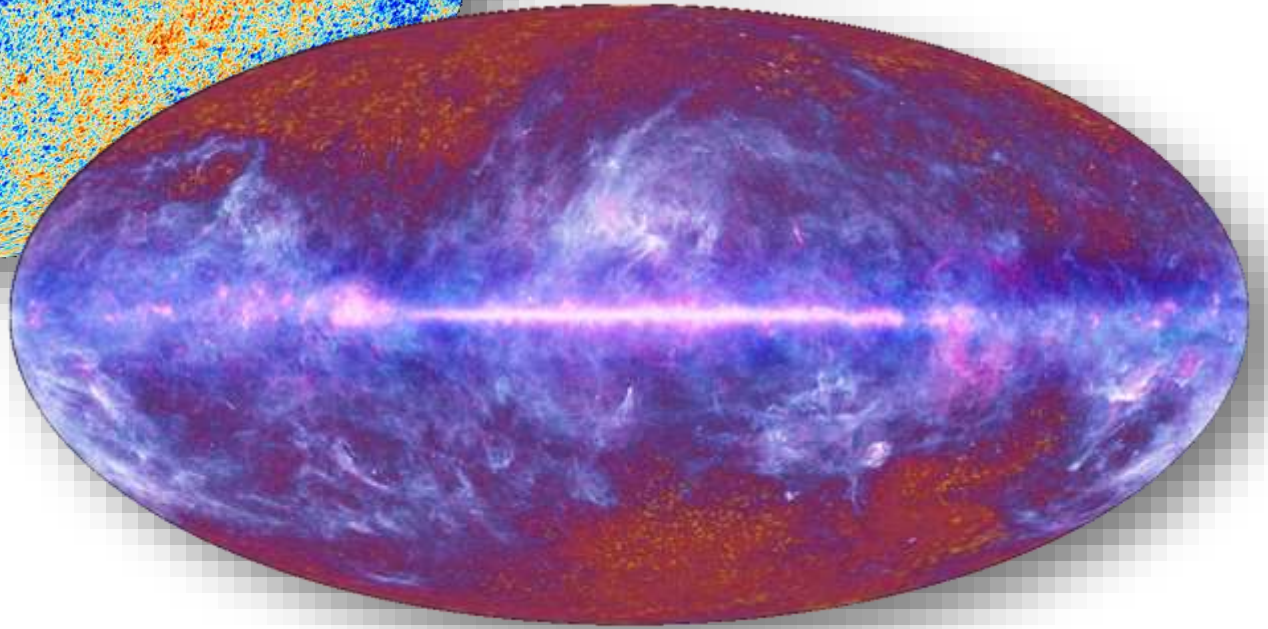
- WG: Extragalactic point sources
(prof. Anne Lähteenmäki)





Wanted:
Cosmic
Microwave
Background

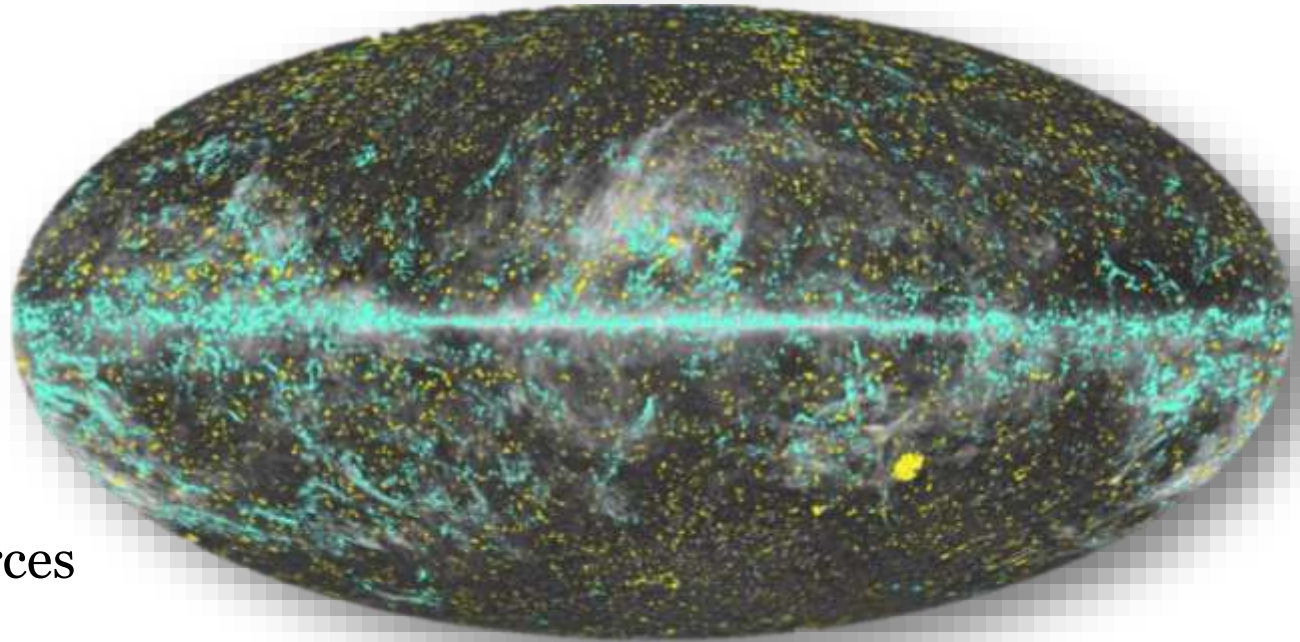
Not wanted:
Microwave
Foreground



Past: Planck

Remove foreground:

- Dust
- Milky Way
- Nearby galaxies
- Galactic point sources
- Extragalactic point sources



In particular: the variable active galaxies

Past: Planck

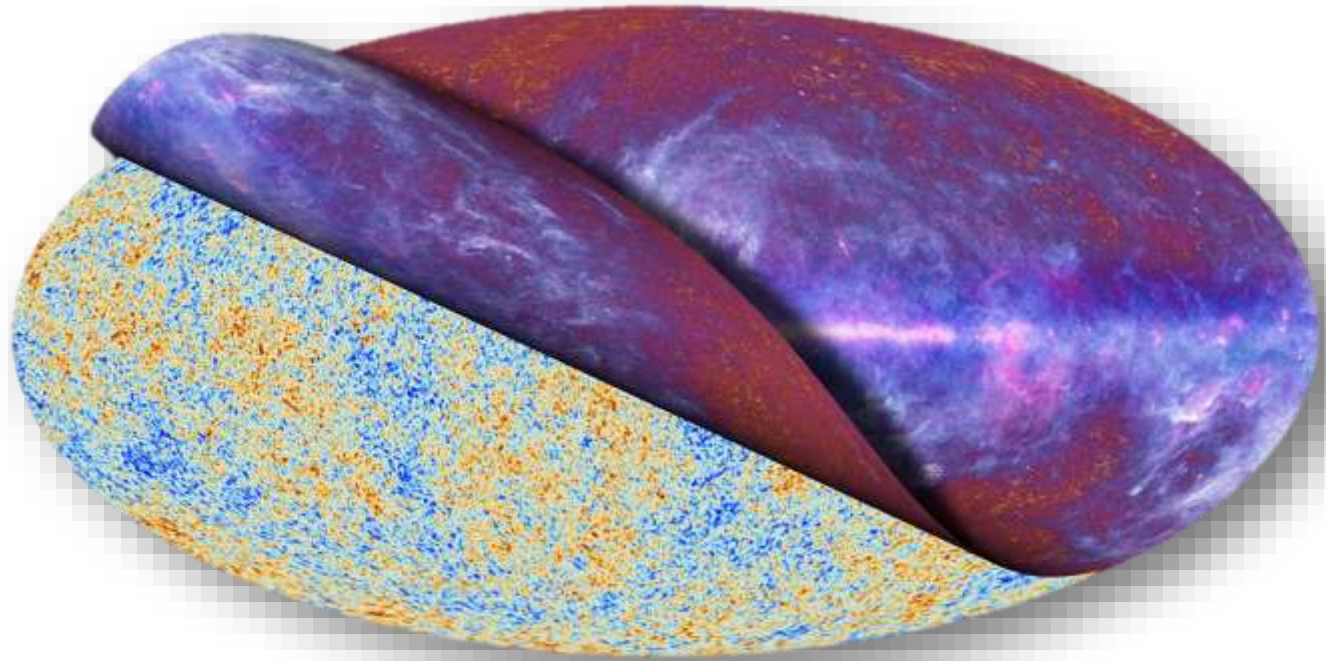
Cosmologist get:

- Pure background

Astronomers get:

- Everything else in the foreground

Win-Win



Present: RadioAstron

Space Radio Telescope

- Russian Academy of Sciences
- Flight: 2011—
- 10-m telescope orbiting the Earth
- Space-VLBI

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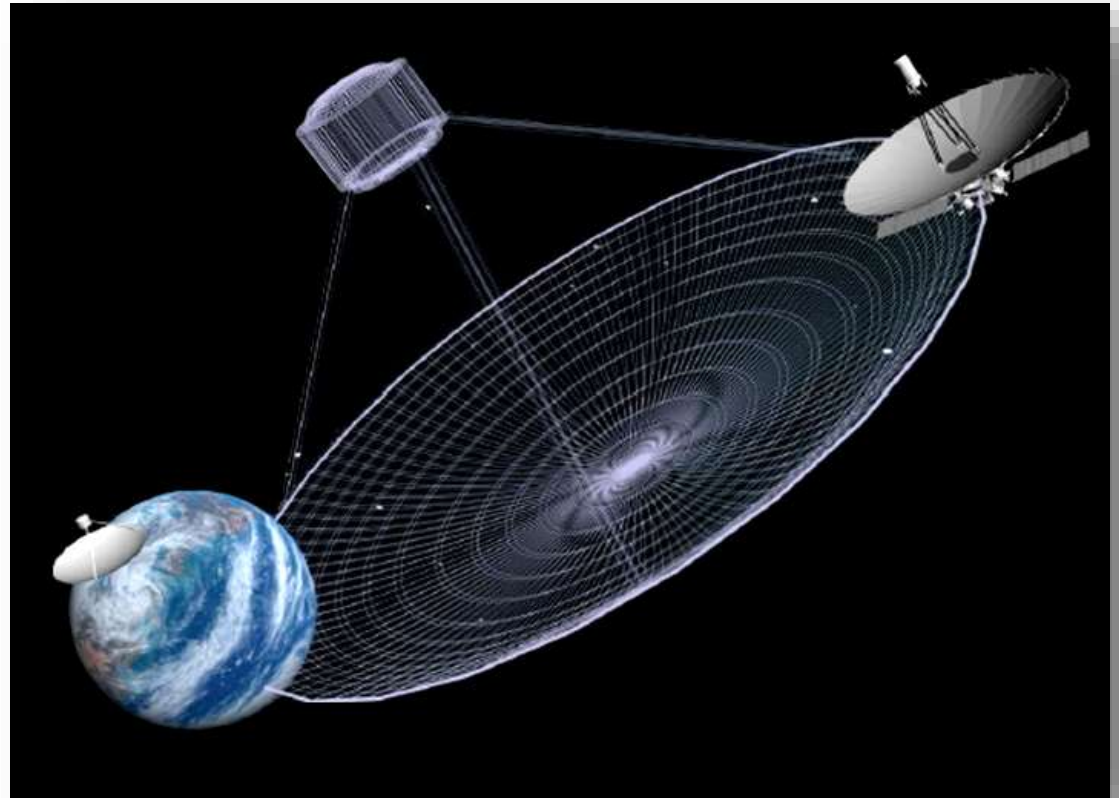
- Astronomy
- Spacecraft observations
- Initially also H/W design
(Prof. Antti Räisänen, RAD)



Present: RadioAstron

Very Long Baseline Interferometry (VLBI)

- Apogee $\sim R_{\text{Moon}}$
- Virtual telescope the size of the Earth-Moon system
- Angular resolution record: 21 micro-arc-seconds

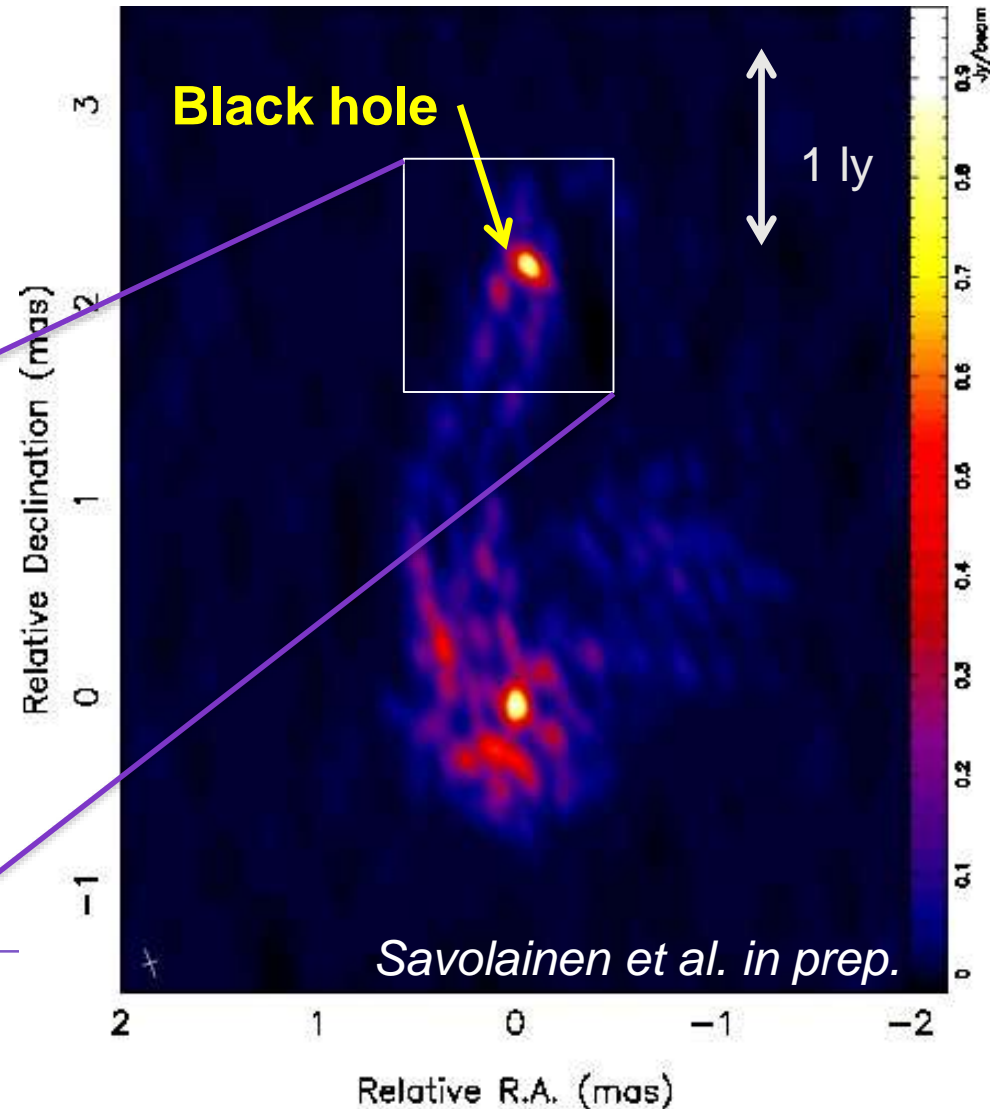
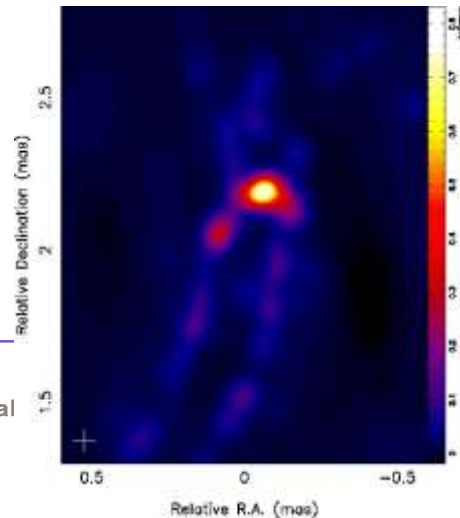


Present: RadioAstron ... as a research tool

Space-VLBI & Astronomy

Key Science Programmes

(Dr. Tuomas Savolainen)



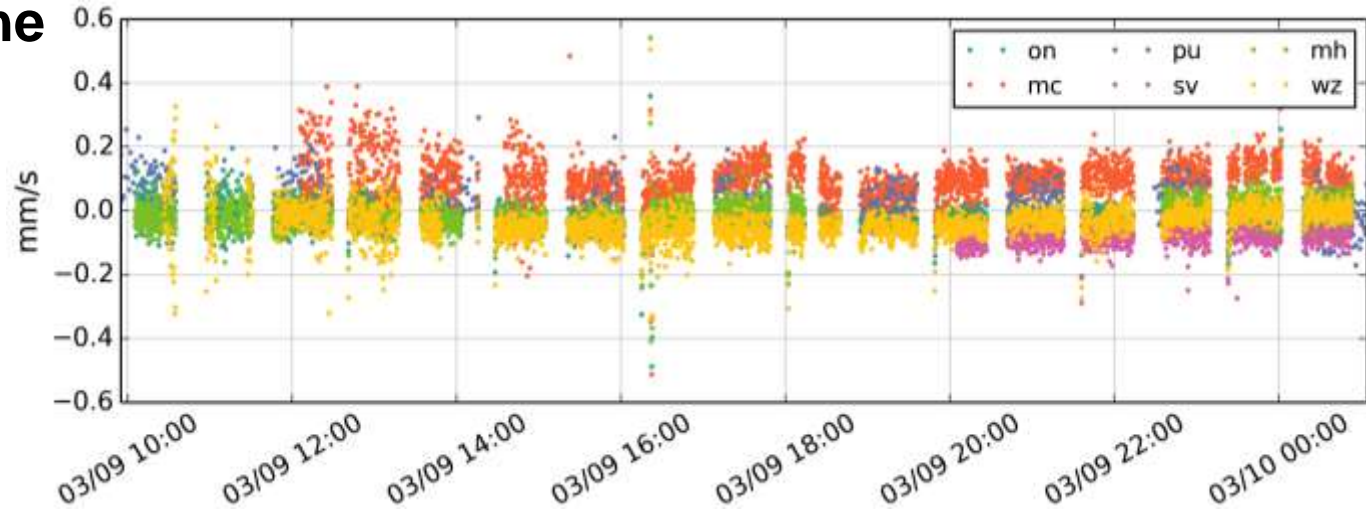
Present: RadioAstron ... as a research target

Orbital parameters of the spacecraft from Earth

- Position: 10 metres
- Speed: 1 mm/s

VLBI & Doppler

- Details:
Dr. Guifré Molera-Calves



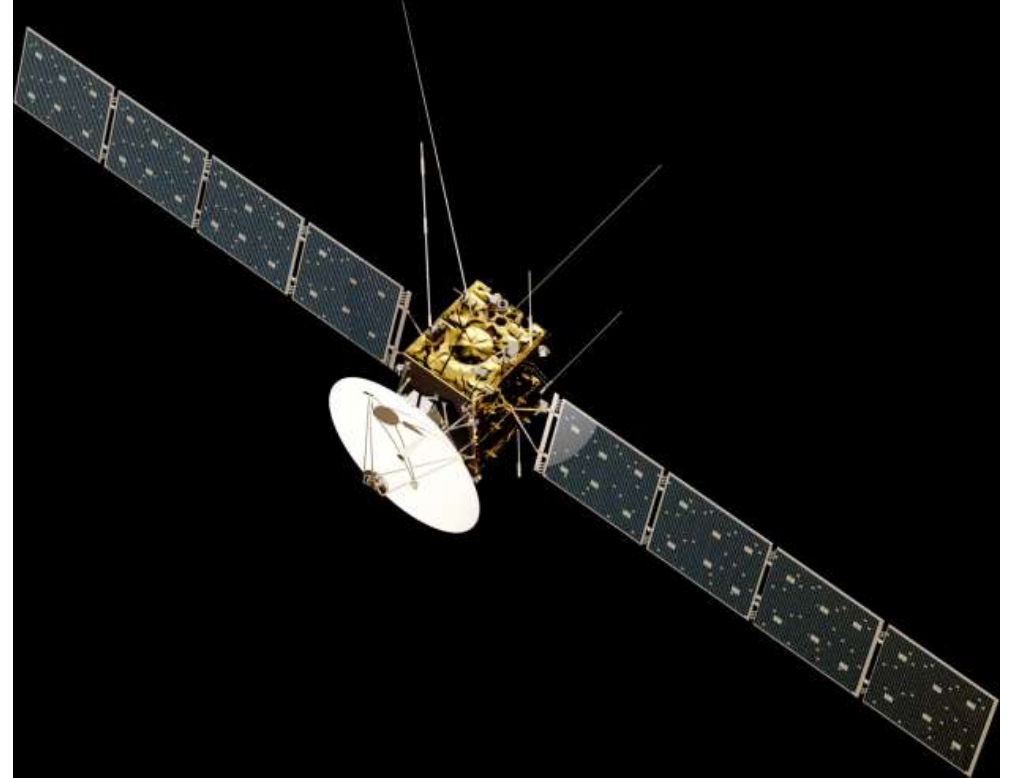
Future: JUper's ICy moon Explorer

JUICE

- ESA
- Flight: 2022—
- Target: Jupiter and moons

Metsähovi

- Planetary Radio Interferometry and Doppler Experiment (PRIDE)



Current development

Metsähovi Compact Array

(Poster)

- Interferometer
- $4 \times 5.5\text{-m}$ radio telescopes



Current development





metsahovi.aalto.fi