Astronomical Antenna for a Space Based Low Frequency Radio Telescope

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Overview

- Radio astronomy
- OLFAR mission
- OLFAR hardware
- Conclusion
Radio Astronomy

VLA Source: John Fowler (2012)

VLBI Source: NASA
Low Frequency Radio Astronomy

• LOFAR (Low Frequency Array)
  • 18+18 stations
  • 10 – 250MHz
  • Max baseline 1500km
Low Frequency Radio Astronomy

- Distortions < 50 MHz
- Opaque < 10 – 30 MHz
- RFI

Source: G. H. Tan et al. (2000)

[Graph showing noise temperature vs. frequency with LOFAR highlighted]
Low Frequency Radio Astronomy

- RAE 1 (1968)
  - Active ionosphere
  - Man made RFI
  - Auroral Kilometric Radiation

- RAE 2 (1973)
  - Very poor angular resolution (~30°)

Source: J.K. Alexander et al. (1975)
OLFAR

Nano-Satellite Swarm (1)

- **Location:** Moon Orbit / Earth-Moon L2
- **Number of nodes:** >10, scalable
- **Node platform:** Nano-satellite
- **Frequency range:** 0.3-30 MHz
- **Max. baseline:** 100 km
OLFAR

Nano-Satellite Swarm (2)

- Very high redundancy
- Very low node complexity
- Very high expansion possibility
- Very high autonomy
OLFAR

Status

• Completed activities:
  • Lunar orbit design and analysis
  • Lunar transfer orbit

• Currently active:
  • Reaction control thruster design
  • (Science) Antenna subsystem design
  • Energy supply

• Starting:
  • L2 point orbit design and analysis
  • Transfer orbit to L2/L4/L5
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Challenges

- 30 Watt power generation
- Low frequency radio antennas
- Fully autonomous, adaptable (true) swarm
- COTS
- 3U CubeSat nano-satellite
Astronomical Antennas

Subsystem Design (1)

- Monopoles
  - 6 x 4.8 meter

- Active electronically short (Nordholt) antennas
  - Compact
  - Flat response over wide bandwidth

- ↑ length -> ↑ efficiency
Astronomical Antennas

Subsystem Design (2)
Astronomical Antennas

RF properties (1)

\(\lambda/4\) resonance - monopole

\(\lambda/4\) resonance - dipole
Astronomical Antennas

RF properties (2)

> $\lambda/2$ resonance - monopole

> $\lambda/2$ resonance - dipole
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Subsystem Design (3)
Solar Arrays
Conclusions

- OLFAR is progressing
- Essential hardware (antennas, solar panels) prototyped
- Science requirements can be achieved with subsystem
- Astronomical antenna properties investigated
- Precursor missions to be investigated
Questions?