AMBREE

Astronomical **M**oon **B**ased **R**adio **E**mission **E**xperiment

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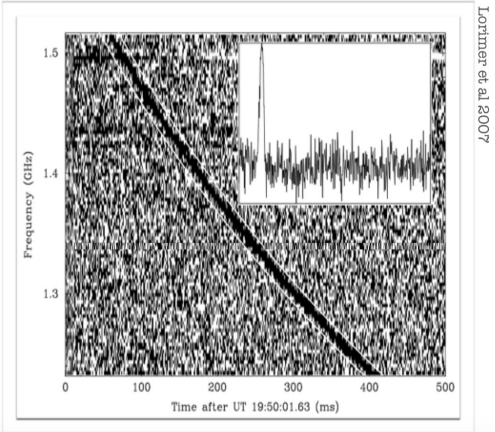
Fast Radio Bursts (FRBs)

- Fast Radio Bursts are of unknown origin, open problem in Astrophysics
- Possible scenarios: NS-WD Accretion, AGN-Kerr BH interaction, NS to Quark Star, Pulsar and BH interaction, NS-NS merger (magnetic braking/magnetic reconnection), Alien Light Sails…
- Important in order to study the physics of the Intra Cluster/Galactic Medium (ICM/IGM)
- Future radio observations from earth-based telescopes: HIRAX, SKA, HERA..



Lorimer et al 2007

Scientific case - main objectives

in site X-ray follow-up

fast localization

study of host galaxies

possible afterglow (model dependant)

Coordination to other telescopes in Optical

possible afterglow, identification of progenitor

Coordination to IceCube and LIGO/Virgo and future GW interferometers

Multimessenger for FRBs and other transients

Scientific case - others objectives

- Radio array : improve timing accuracy for pulsars
- Radio & X-ray : observations of jets

Accretion/ejection model

- In site X-ray telescope : GRBs, Supernovae, X-ray binaries

- Wide Radio band observation : Discover new transients

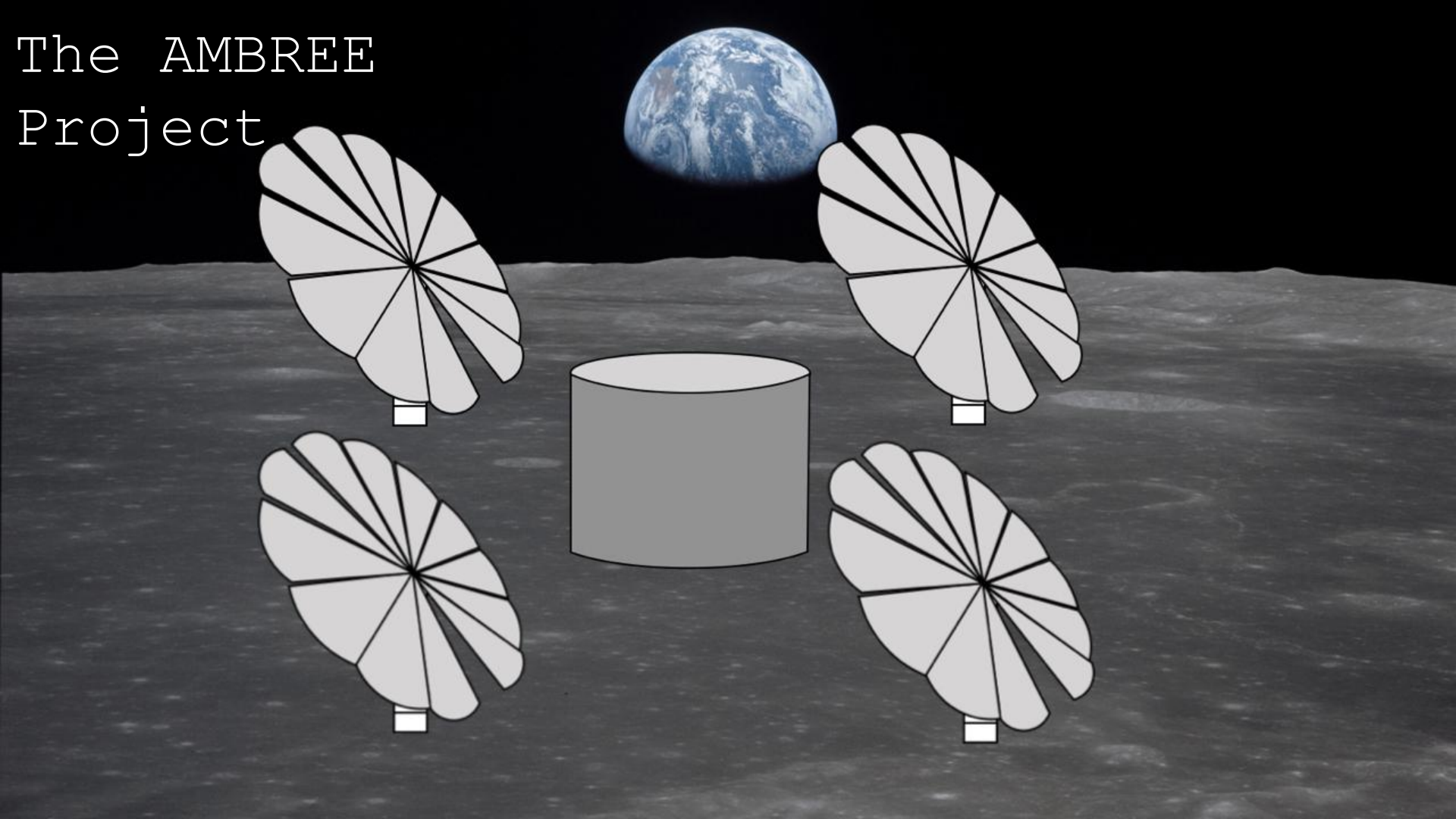
➔ Establish a moon base!

Mission concept & Design

- Launch : main mission through heavy engine launcher (SLS by NASA)
- Installation : use Artemis mission (2028) future base to deploy antennas
- Localisation : South Pole-Aitken Basin (2500 km) on the far side of the Moon
- Possibility to add new antennas with future Moon missions

- Foldable antennas
- X-rays imager and spectrometer
- Data processing unit
- Transmitter on a nanosatellite on a L2 orbit (of the System Moon-Earth)

The AMBREE Project



How to get there

- Foldable antennas & detectors inside the launcher : light, compact, easy to launch

- Solar panels for energy supply : same technology
- X ray telescope can be built by robots on the moon

Why on the Moon?

Pros

- shielded from everything coming from Earth => no interferences
- observe the same object continuously during 14 days
- lack of atmosphere (can observe in all the wavelengths)
- No conflict with 5G telecommunications
- no radiation belt passage
- unlimited accommodation for large instruments

Cons

- Moonquakes
- Extreme temperatures (-173°C - 100°C) => technology is already achieved ✓
- Asteroids?
- Solar energy? Solution: solar panel array at a location that can always follow the sun + storage facility ✓

Radio

Pathfinder : 6 antennas

Phase I : 20 antennas with a baseline of 100 km

Frequency sensitivity : 0.1 - 10 GHz

Varying size of antenna dishes in order to cover all desired frequency band

FoV : 31°x31°

X ray

Ground based !

Large Energy band: 0.1 keV-150 keV

Wide field of view: coded mask with 31°x31°

Spatial resolution of 0.06°

Size of the mask: M = 7 m

Size of the detector: D = 1 m

Distance mask-detector: L = 10 m

Mask element size: H = 1 cm

Data processing

- ➔ Need of computational power on the moon in order to have instant signal emission to the X-ray follow up observation
- ➔ Machine learning algorithms for fast signal processing
- ➔ Send alert to Earth facilities for multi-wavelength observations

Budget, timeline, collaborations

- Costs : 500 M $ for the space rocket and lunar lander (based on SLS mission)
- Construction will start with the approval of the proposal, expected launch in 2050
- International Collaboration of: SpaceX, NASA, ESA, Max Planck for Radioastronomy, University of Amsterdam, National Institute for Astronomy - Sardinia, Cagliari Astronomical Observatory, CEA - Saclay
- Large class missions (L): maximum cost 900 M $.
- Phase II : more antennas (also in the near side of the moon), gamma ray telescope

Grazia per a
vostra attenzione!