Low **OrB**it **S**urvey **T**itan **E**nergetic **R**adio array (**LOBSTER)**

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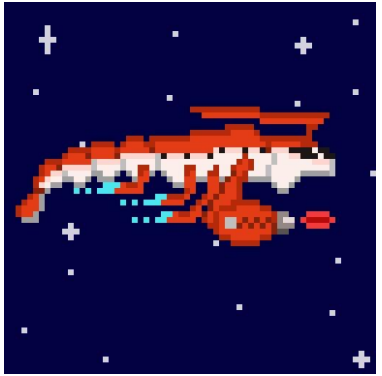
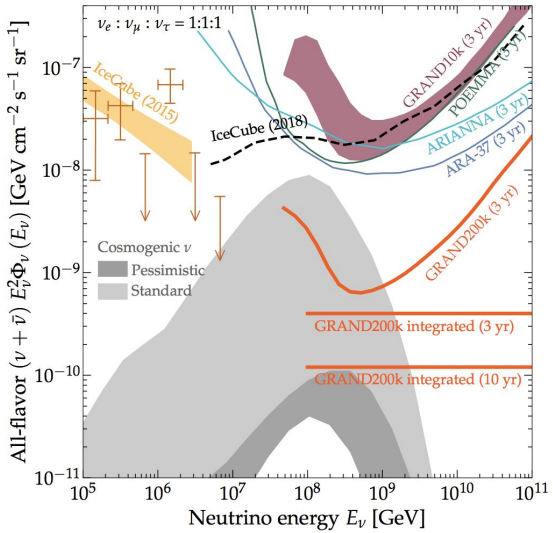
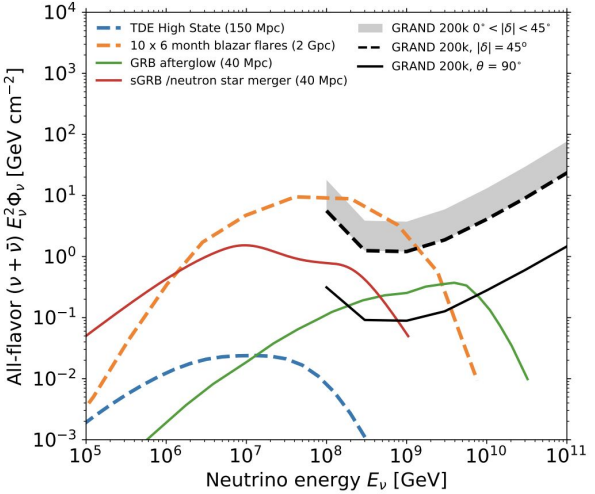


Scientific Aims

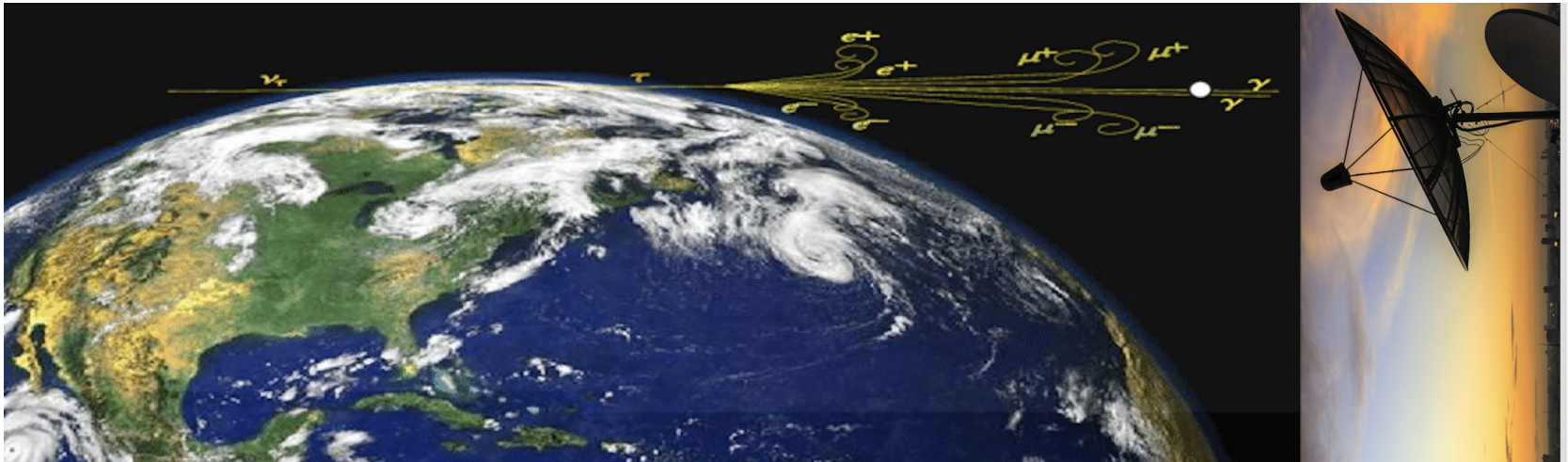
- Significant interest in ultra-high energy (UHE) cosmic rays and neutrinos
  - GRAND (mountain target with 200k radio array)
  - POEMMA (Cherenkov radiation from space)
  - ARA-37 & ARIANNA (in-ice radio detectors)
  - ANITA (balloon-borne radio detectors)
- Study cosmogenic UHE neutrino flux in PeV - EeV range
  - Partially unprobed energy range with 100 - 1000 times higher flux
  - Obtain full-sky map
- Determining the source of acceleration of highest energy cosmic rays (above the ‘ankle’)
- UHE neutrino transient sources
- Search for steady point sources of UHE neutrinos





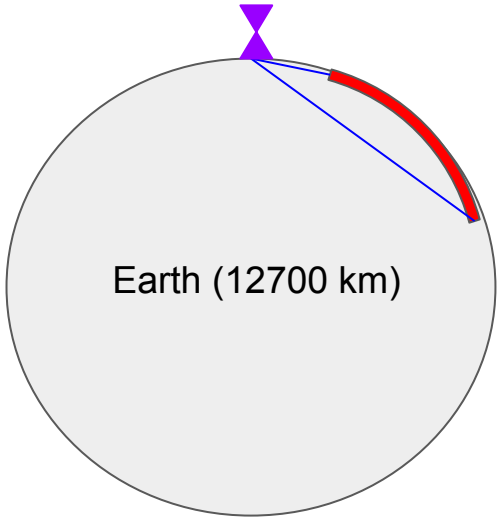
Principle

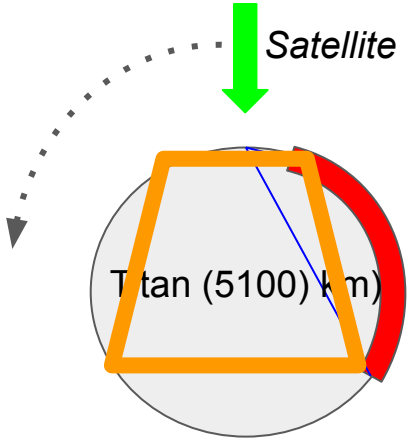
- High energy neutrinos interact in rock producing tau particles
- Tau particles interact with atmosphere create extensive air showers
- Shower particles gyrate around (e.g. Earth’s) magnetic field and produce synchrotron emission
- Emission can be detected at radio frequencies



Placement of antennae on Titan

- Distance traveled in rock for neutrino interaction to produce tau
  - 100-1000 km for Earth (GRAND)
  - Scales to 140-1400 km for Titan mean density (1.88 g/cm3 compared with 2.26 g/cm3 for Earth rock GRAND)
- Titan parameters
  - Atmospheric density: 4.4 that of Earth's, so air shower will be produced
  - Magnetic field of Saturn at Titan is 0.001 G (comparable to 0.01 G of Earth)





- **Flux x100 per satellite unit**
- **100-1800 events/year (at EeV energy)**
- **No atmospheric CR and neutrinos**

General design

- MotherLobster with computation node and accurate atomic clock
- Array of antennae deployed in two low Titan orbits (300 km, 310 km)
- Frequency range: 5-80 MHz
- Detailed Monte Carlo required for optimal array layout
- Open observatory; *for a better world*™

Improvement on current and proposed facilities

- Neutrino flux
  - Increase neutrino detections by a factor of 100 - 1000
- Atmospheric background
  - Major problem with ground-based neutrino detectors is the flux of atmospheric neutrinos
  - Antennae in space significantly reduce this problem
- Sky coverage
  - GRAND has very limited sky coverage
  - LOBSTER will survey entire sky
- Efficient collective area

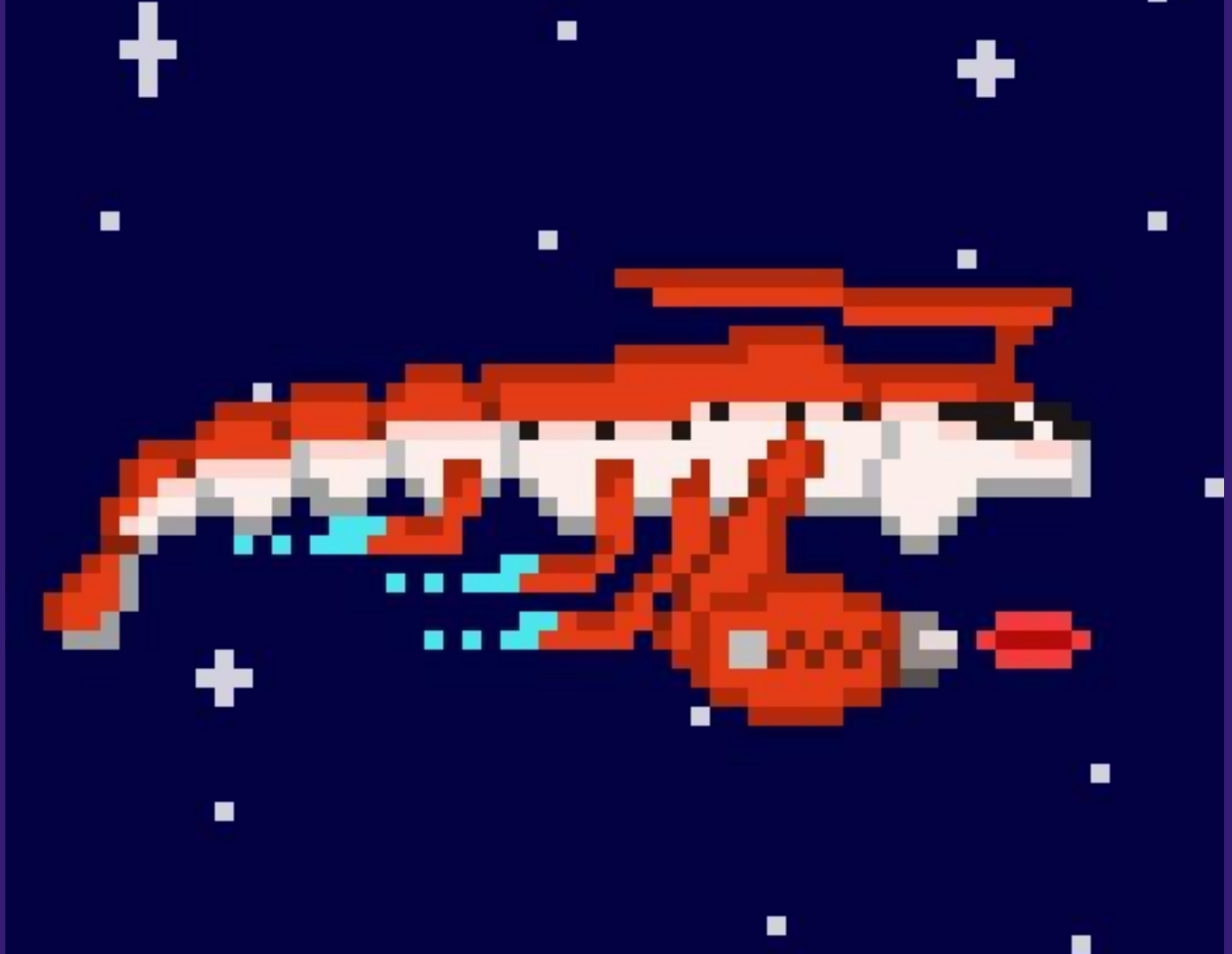
Secondary science aims

- Radio studies of Saturn and its moons
  - Mapping exoweather via lightning detection
- Use LOBSTER as a radio relay device
- Timekeeping needed for accurate timestamps also allows for studies of celestial mechanics over large stretches of time very accurately
  - Orbits of Titan and Saturn
  - Tests of gravity in the weak regime

Budget estimates

- Pre-launch development:
  - 1000 antennae (source: GRAND): 100 M
  - Solar panels + 10 Uranium batteries for electronics: 50 M
- Launch vehicle and launch services: 502 M (source: Cassini)
- Tracking: 50M (source: Cassini)
- Mission operations for 10-year lifetime: 198 M
- **Total: 900M**

- Second possibility: Piggyback



Thank you for your attention