Poster Session #F
Gravitational Wave detectors and other sources

F03

Lunar Gravitational-Wave Antenna

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Monitoring of vibrational eigenmodes of an elastic body excited by gravitational waves (GWs) was one of the first concepts proposed for the detection of GWs. At laboratory scale, these experiments became known as resonant-bar detectors first developed by Joseph Weber in the 1960s. Due to the dimensions of these bars, the targeted signal frequencies were in the kHz range. Weber also pointed out that monitoring of vibrations of Earth or Moon could reveal GWs in the mHz band. His Lunar Surface Gravimeter experiment deployed on the Moon by the Apollo 17 crew had a technical failure, which made it impossible to carry out a search for GWs. In this poster, we present the Lunar Gravitational-Wave Antenna (LGWA) concept recently submitted in response to the ESA call for ideas for a lunar exploration from the European Large Logistic Lander (EL3) and expanded in a paper (https://arxiv.org/abs/2010.13726). There are significant technical challenges of realizing its science payload, i.e., a high-performance seismometer, and of the deployment and operation of the experiment. Key to the planning of LGWA is our understanding of the lunar interior and the lunar surface conditions. The lunar interior structure determines the Moon's response to GWs. Surface conditions can have a great impact on the seismometer performance. For example, regions with temperatures constantly below 40K were found in permanent shadows near the lunar south pole by the Diviner Lunar Radiometer Experiment, which might enable the implementation of superconductor technology. In such environments, even vibration-free Helium sorption cooling might be an option to further stabilize and reduce the temperature of the system and thereby increase the seismometer sensitivity. The LGWA science case has potential for breakthrough discoveries like the direct association of a double white-dwarf merger with a supernova type Ia due to a potentially superior 0.1-1Hz sensitivity compared to other GW detectors that will or might be realized in the coming two decades, and excellent source-localization capability since a distributed seismometer network can be deployed, and also the month-long rotation period of the Moon gives an advantage over the year-long period of the LISA detector orientation. Like LISA, LGWA would be able to see massive binary black-hole mergers out to high redshift, and could potentially form an efficient tandem with LISA or other potential LISA-type detectors for observations of such signals. A distributed seismometer network would also make it possible to measure the polarization content of a GW and to carry out novel tests of general relativity.