Fundamental Physics with the ASI Lunar Mission MAGIA (Phase A Study). Simone Dell'Agnello[1], Douglas Currie[2], Giovanni Delle Monache[1], Roberto Vittori[3], Giovanni Bellettini[4,1], Riccardo March[5,1], Roberto Tauraso[4,1], Alessandro Boni[1], Claudio Cantone[1], Marco Garattini[1], Caterina Lops[1], Manuele Martini[1], Claudia Prosperi[1], [1]Laboratori Nazionali di Frascati dell'INFN (INFN-LNF), Via E. Fermi n. 40, Frascati (Rome), 00044, Italy, simone.dellagnello@lnf.infn.it, [2]University of Maryland, College Park, Maryland, [3]Italian Air Force, Rome, Italy, [4]University of Tor Vergata, Rome, Italy, [5]CNR-IAC, Rome, Italy.

Introduction: In October 2007 the Italian Space Agency (ASI) issued a call for "Small Missions" to select two missions to be launched within 2014. In February 2008, out of the about 25 proposed missions, 5 were selected by ASI for Phase A study. The two missions approved at the end of the Phase A study will be financed with 50 Meuro, excluding the cost of VAT and the cost of the launch.

One of the 5 missions selected for Phase A study is MAGIA (Missione Altimetrica Gravimetrica geochimica Italiana lunAre), an altimetric, gravimetric and geochemical Italian mission. Current design of MAGIA is a formation of a main lunar orbiter and of a sub-satellite. The Prime Contractor of MAGIA is Rheinmetall Italia S.p.A., the Principal Investigator is Angioletta Coradini of the Istituto Nazionale di Astrofisica, Istituto di Fisica dello Spazio Interplanetario (INAF-IFSI).

Fundamental Physics: In addition to planetology science, MAGIA is being conceived to perform fundamental physics measurements during the transfer flight and during the lunar orbiting period.

Measurement of the Gravitational Redshift. The best measurement to date is from Gravity Probe A [1] launched in 1976. We plan to study a payload consisting of the atomic clock onboard MAGIA and of a laser retro-reflector array (LRA) to improve the measurement of GP-A for a precision test of General Relativity and new theories, like [2]. Different clock and LRA options are under study (both for the transfer flight and the lunar orbit) and will be presented.

Precursor Mission for the Proposal LLRRA-21. Within the LSSO Program, NASA has approved a project for the design, construction, analysis and test of a new Lunar Laser Ranging Retroreflector Array for the 21st Century (LLRRA-21) to improve by a factor 100 to 1000 the lunar laser ranging accuracy over current arrays deployed by Apollo missions 11, 14 and 15 [3]. LLRRA-21 will test General Relativity and unified theories like in ref. [4].

We are studying the option to deploy on the MAGIA orbiter the flight prototype of LLRRA-21. This will allow an important precursor mission to prove the functionality of the basic 100-mm diameter cube corner retroreflector (CCR) of LLRRA-21 at Earth-Moon distances with current laser ranging stations. One of these stations is APOLLO at Los Alamos of interest to NASA; another one is MLRO, Matera Laser Ranging Observatory, of interest to ASI. From an enviromental point of view, this precursor experiment will not test the thermal conditions of the moon surface, but it will test the effect of solar illumination simultaneous to the laser ranging measurement. In fact, from a thermal point of view, the CCR must retain sufficient optical quality so that the retro-reflected beam will provide the concentration of light back at the ground station. The CCR must retain this performance in spite of the effect of the solar radiation that is absorbed within the CCR and then radiated into space. These thermal effects will be modeled with the Thermal Desktop software of C&R-Tech and experimentally optically tested in a realistic space enviroment at the INFN-LNF SLR Characterization Facility (SCF) in Frascati, Italy [5]. This will be a synergetic effort between this sub-group of MAGIA and the LLRRA-21 authors.

Measurement of the Selenocenter. We will study the feasibilibty of a direct measurement of the Selenocenter with respect to the ITRF by means of laser ranging to MAGIA in orbit around the moon. During the lifetime of the mission such a measurement will allow for an independent check of current results of lunar laser ranging obtained with the Apollo LRAs on the surface of the moon since forty years.

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