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IAF SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 3 (2C)

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SMAD: A SUPERCONDUCTING MASS DRIVER CONCEPT DESIGN

Abstract

With the Moon being rediscovered in its relevance, many suggest the viability to use lunar resources to support humanity's exploration into the solar system. Besides in-situ-resource-utilization, to make a future space economy prosper, a sustainable launch system from the Moon's surface needs to be implemented. Mass Drivers offer the unique possibility to launch material from the surface into lunar orbit without additional propulsive systems, provided that it is launched from the equatorial line, oriented for allowing the exit trajectory to pass through the Earth-Moon Lagrange points L1, L2, L4 or L5. If shot with the right velocity into these points, a catcher system at the designated Lagrange point stops and collects the material, to be further processed at the same spot. This is enabled by the tidal lock of the Earth-Moon system and the lack of atmosphere on the Lunar surface. The ability of "dumb" launches of payload without propulsion systems into the target area significantly reduces marginal operation-cost, opening up commercial frontiers. We conceptualize this system based on superconducting electro-magnetic levitation and present a viable preliminary design. It has been described by Powell et al.(2001), yet we rely on benefiting from lunar environmental conditions in order to run such infrastructure without complex cooling and vacuum systems offering a threefold reduction of technical complexity compared to terrestrial settings:

1. Launcher-magnets are made of rare-earth barium-copper-oxide–based superconductors, a rapidly growing technology developed in many research centres (Rossi, 2015; SPARC,2020; Buzzone,2018), with the possibility of working between 50 to 70 K. These temperatures are kept by using Mylar foils and Peltier elements in combination, eventually enabling day time functionality;
2. a natural vacuum of about 10^{-11} mbar enables us to avoid the need for a dedicated vacuum tunnel to minimize the friction;
3. The payload needs a maximum speed of mere 2380 m/s. Our calculations result in an acceleration of no more than 30 m/s^2.
4. This way no additional chemical propulsion system is needed to achieve a basic lunar orbital insertion. Finally, an energy storage system based on photovoltaic panels and superconducting flywheels has been considered, in order to store energy during sunny phases.

In this preliminary conceptualization we focus on solving design challenges at the current technology base. An outlook into the future lets us expect further improvements, e.g. in coils/magnet design, that facilitate the development of such infrastructure.