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A number of scientific justifications have been given for conducting physics and astronomy experiments on the Moon [1-7]. These take advantage of several distinct features of the Moon, viewed primarily as a stable solid platform with low gravity, ultra-high vacuum, dark cold sky, rigorous ephemeris, and long integration and exposure time [8]. Access from Earth and proximity to Earth conjures up an image of a very stable Earth-orbiting satellite which would simplify space science operations considerably. When viewed as another world, the Moon represents an even more remarkable contrast to many of the limitations of Earth-based experiments such as seismic and atmospheric noise as well as background limits introduced by the Earth’s magnetic field. It is this last perspective which has prompted many to argue that in some respects, the Moon borders upon being revolutionary as a new scientific laboratory in the next Century. The Moon, indeed, would provide a welcome sanctuary as a remote, quiet place for certain experiments in fundamental physics [9].

In contrast to the above point of view, however, there is the reality of science as a human enterprise. The image of the Moon as a place for large-scale observatories in astronomy or for grand-scale laboratories in fundamental physics inevitably comes into conflict with traditional, Earth-based programs [5,10]. It is this aspect of science on the Moon which represents one of the most difficult and complex next steps in a sound scientific justification for a return-to-the-Moon program. Many of the previous arguments [1-4] have been described as "hand-waving" exercises when Earth-versus-Moon comparisons are made [10]. It is clear that the lunar science community needs to prepare a stronger argument for claiming that the Moon is a better place than the Earth for conducting certain experiments.

To this end, the controversial issues must be identified early on. For fundamental physics and particle astronomy [11], one of the problems is radiation backgrounds [7, 12-13]. A broad illustration of the problem [11] is depicted in Figures 1 & 2 where many of the basic sources of particle radiation have been represented. Except for a tenuous and transient exosphere, the Moon appears to have no appreciable atmosphere. Although an absence of atmosphere creates a remarkable advantage for neutrino astronomy [1,11] by elimination of local atmospheric neutrinos, it exposes the Moon’s surface to direct impingement of cosmic radiation and solar protons which aggravates the production of prompt neutrinos via charm decay. Early estimates [14] of charm decay are shown in Figure 1, indicating some advantage for neutrino astronomy on the Moon. These, however, are somewhat out of date due to changes in the branching ratios for charmed meson decay. They also depend strongly upon the cosmic ray flux incident at the planetary surface, and these are not yet rigorously determined for the Moon.

Although the mechanisms which define the particle radiation backgrounds in Figure 2 are well-understood, very little work has been done to ascertain the actual...
background levels. Like the Earth, the Moon is also a source of radiation and noise. Virtually no work at all has been directed at a scientific, Earth-versus-Moon background flux analysis - other than this present discussion and perhaps NASA's Stanford Workshop [1]. The Moon is, for the most part, presumed (and not demonstrated) to provide a superior environment for conducting physics and astrophysics experiments. Considering that science is supposedly the centerpiece of a return to the Moon effort, much work remains to be accomplished.

Figure 2. The particle radiation environment on the lunar surface. The discovery of charm in particle physics has radically altered our understanding of some of the processes taking place on the Moon.

References: