Marshall Problem Statement / Senior Design Topic

Problem Title: Terraforming From L1

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Indicate which discipline/s is/are most appropriate to work on this problem, **Aerospace**, mechanical, electrical, industrial, civil, computer, **physics**, materials, nuclear, **earth science**

Marshall Problem Statement

Background: The big picture with references to previous work:

When considering terraforming planets, either in this solar system or others, the light spectrum and light intensity is often problematic. In the case of Mars, the light is of the right spectrum but the intensity is inadequate. In the case of Mercury or Venus, the light spectrum is correct but the intensity is too high. In the case of a star like Trappist-1 the spectrum is shifted too far to the red and depending on which planet is being considered is either too intense or too weak. Also, many planets lack a strong magnetic field allowing the solar wind to strip the atmosphere away in some period of time. Without a strong magnetic field, the radiation on the surface of a planet is sometimes excessive. There are no known papers on this subject, it is new territory.

The project would be to design a device to be located at the star/planet's L1 point. This device will be massive. It will do several things. One it will power itself by the solar energy from the planet's star. Consider our own sun with respect to Mars and Venus but also the planets around Trappist-1 and in general small rocky planets around any star. Two, it will provide light for the target planet identical in spectrum and intensity to that of Earth. Three, it will generate a large magnetic field to deflect the star's solar wind from the planet, protecting it from atmospheric erosion and radiation. Four it will provide high powered lasers to power spacecraft and deflect asteroids and other debris that may threaten the planet. Five, it may vary the light intensity (in the case of tidally locked planets to simulate Earth day-night cycles and maybe Earth seasons. Six, because this is a massive structure, in space, with significant energy reserves, what are the prospects for antimatter production?

Recent/on-going research on the problem

There are a number of articles in the Journal of British Interplanetary Society (JBIS) that touch on some of these topics and a literature search will be part of the this effort.

Details of the problem; design constraints, requirements (if any), outcome expected (one semester Senior Design course lasts 15 weeks; two semester course lasts 30 weeks.) (What do you expect the senior design team to accomplish?)
The expected outcome is a peer reviewed article published in a reputable journal detailing the research results.

With respect to objective one. How might a very large structure in space intercept a star's energy, and transport it around the structure? Is storage possible? How good are our current solar cells and what future advance can realistically be expected. How will these solar cells survive in space and how often must they be replaced? Given the massive structure, how stable is it at the L1 point? How much maneuver capability is required?

Objective two. How can light of the appropriate intensity and spectrum be provided to a distant planet? How efficient are lasers? How do we deal with waste heat? Is there another energy conversion technology that might be better?

Objective three. How can this large structure generate a magnetic field large enough and powerful enough to deflect most (all?) of the solar wind. Trappist-1 is a flare star and the planets are very close so for it the requirements may be much larger than for Mars. Some modeling may be required to address this question as I'm not aware of a straightforward equation that can answer this question. Are superconductors required for this? Once established, how much energy is required to maintain this magnetic field?

Objective four. Given the excess energy available can megawatt laser systems be provided? What might they look like? What kind of tracking and optics are required?

Objective five: Consider various planetary configurations such as tidally locked, to high spin planets. How might an Earth like 24 seven day be achieved and can we duplicate the Earth's tilt and the resulting seasons?

Objective six. Antimatter production. Is this a feasible? How might it be accomplished and how might the product be stored?

This would be considered to be a mega structure. How might it be constructed and what type of resources would be needed?

If alien races are using such device already, how might they be detected?

Senior Design Project Rules:

1. Weekly telecons will be scheduled to maintain proper progress and prevent dead-end ventures.

2. Deliverable/s required (e.g. one semester course – a written final report; two semester course – written final report and a prototype/model (if practical))