GP 2 (Berkeley Grant Game): Discovery phase

Since the launch of your probes, the TPF has found out more about the planets in the Bigun system. First, they orbit in the same direction around the star, all on the same orbital plane. Second, their orbital periods and semi-major axes have been measured:

<table>
<thead>
<tr>
<th>Planet</th>
<th>h Bigun A</th>
<th>h Bigun B</th>
<th>h Bigun C</th>
<th>h Bigun D</th>
<th>h Bigun E</th>
<th>h Bigun F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semi-major axis (AU)</td>
<td>0.5</td>
<td>1.5</td>
<td>2.5</td>
<td>4.5</td>
<td>6.0</td>
<td>7.0</td>
</tr>
<tr>
<td>Orbital period (yr)</td>
<td>0.35</td>
<td>1.84</td>
<td>3.95</td>
<td>9.55</td>
<td>14.70</td>
<td>18.52</td>
</tr>
</tbody>
</table>

The “discovery” phase consists of the following moves (each period, you may do up to one of each):

- **Submitting a grant proposal** on the proper form. The group name, a short description of the experiment to be done and the costs of the experiment are necessary ingredients for a valid proposal. **Be as specific as you can.** For instance, “Joe University wants to look at planet B” is not very specific; “Joe University wants to take two infrared (IR) measurements using TES spaced two hours apart of the atmosphere of planet B to determine any changes in composition” is a much better proposal. The outcome of the proposal will be determined by the Grant Committee. **Funded** proposals will have the results of the experiment written on the back of the proposal form. **Unfunded** proposals will be returned to the group and may be reworked into another proposal.

A note about movement: You may direct your probe to orbit a particular planet or moon or to land or take-off from a planet or moon surface. However, you can move only prior to any use of an instrument. In other words, you can land on a planet and take a picture, but you can’t land on a planet, take a picture and then take off and take another picture.

A note about instrument usage: You may use each of your instruments once per proposal; you may choose to use one or more of your instruments per proposal. For instance, you can use the Mossbauer and the TES on the same proposal, but you can’t use the TES on two different parts of the planet on the same proposal.

- **Submitting a manuscript** for publication on the proper form. The group name and a short legible write-up (see below for different types) are necessary for a valid manuscript. The outcome of the manuscript will be determined by the Journal Editor. Each journal has a set of editors that evaluate the manuscripts that are submitted to them. A manuscript will be accepted for publication only if it has significant new research and the evidence justifies the conclusions the authors reach. A published manuscript is called a paper.

There are many types of papers: for convenience, we will consider two types only. The first is an **observation** paper; as the name implies, this paper will simply state or
display an observation, with a minimum of interpretation of what the observation means. The other is a theory paper. Theory papers are those that have a hypothesis for which the authors provide ample evidence from their own research (published or not) or from another group’s published research. A citation (the publications will be numbered in the order that they are received) to the number of the previously published paper is necessary. The journal will be placed next to the group roster sheet, so that everyone may inspect the publications.

Please see the examples on the next pages. Notice that, since theory papers score significantly more points than observation papers, they will be held to a higher standard of supporting evidence and citation.

A rejected manuscript does not have to be thrown out. Usually, the editors point out what was wrong with the manuscript, and therefore, it should be revised and resubmitted.

**Scoring:** As in life, you are rewarded for the completion of your project and for your publications. In life, your group gains prestige and getting proposals funded and papers published becomes easier. In this game, you get **points**:

<table>
<thead>
<tr>
<th>Type of Manuscript</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Funded proposals</td>
<td>4</td>
</tr>
<tr>
<td>Observation paper published</td>
<td>2</td>
</tr>
<tr>
<td>Theory paper published</td>
<td>6</td>
</tr>
<tr>
<td>Citation of your paper by another group</td>
<td>1</td>
</tr>
</tbody>
</table>

A maximum of **fifty points** will be given for this group project and all group members share the same final score.

Observations from previous Berkeley Grant Proposal Games:

- Groups which have neglected the Journal board have produced redundant manuscripts, which are summarily rejected.
- Publishing nothing but observation papers does not accrue very many points.
- Your group, of course, is the first group to see your particular results. This is probably a good time to simultaneously write a theory manuscript based on your results!
- Since the manuscripts are numbered consecutively as they are submitted, only the group which submitted its manuscript **first** will be published for that particular result.

Here are some **questions** to help you frame both observation and theory papers; notice that the questions require progressively **more evidence**:

1. How many moons are in the system, and what planets do they orbit? What instrument did you use?
2. Do all of the moons rotate in the same direction? How can you tell?
3. What is the orbital period of different moons? How can you tell?
4. What is the rotational period of the different planets? How can you tell?
5. How eccentric are the planets’ orbits? How can you tell?
6. Does the star itself rotate? In what direction? How long does it take to rotate?

7. Is there evidence of objects besides planets or moons in this system? How can you tell?

8. Are there terrestrial planets? Are there gas giants? How can you tell?

9. Does this planetary system have a volatile/refractory distribution similar to our solar system?

10. What substances are the surfaces of the terrestrial planets made of? What instrument did you use?

11. What substances are the surfaces of the moons made of? What instrument did you use?

12. Is the surface material that is detected from orbit the same when the surface material is actually sampled? If not, what might be the reason for the discrepancy?

13. Do any of the terrestrial planets or moons have an atmosphere? If so, what is the composition of the atmosphere and what instrument did you use?

14. What substances are the gas giants made of? What instrument did you use?

15. Is there evidence for plate tectonics on any body? How can you tell?

16. Is there evidence for oceans (or large liquid areas) on any body? How can you tell?

17. What temperature ranges exists on different planets and moons? What instrument did you use?

18. Is there any direct evidence for life on any planet? What is this evidence?
Grant Proposal Form

University name ____________________________

Total cost of proposal ________________

Proposal (no more than one paragraph):

____________________________________(for
Grant Committee use only)

Approved _____ Denied _____ Reason:

On the back of the returned proposal form:
Group name: ___________________________________________

Keywords (ALL CAPS):

Paper:

(for Journal use only)

Accepted: Observation _____ Rejected: _____ Reason:

Theory _____