

**NASA SOLAR SYSTEM WORKINGS PROGRAM  
PANEL EVALUATION OF  
PROPOSAL SUBMITTED IN RESPONSE TO NRA: NNH14ZDA001N-SSW**

**Proposal No.:** 14-SSW14\_2-0113

**PI Name / Institution:** Rathbun, Julie / Planetary Science Institute

**Proposal Title:** *Galileo PPR observations of Europa: Correlations of thermophysical properties with endogenic and exogenic processes*

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**1. BRIEF SUMMARY OF RESEARCH OBJECTIVES:**

The goal of this work was to characterize the variations in the Galileo Photopolarimeter-Radiometer (PPR) data to determine if they are controlled by exogenic or endogenic processes, and to account for the change in incident sunlight with latitude which was not accounted for by Rathbun et al., (2010). In the proposed work, this oversight would be corrected and the analysis would be further extended by including 7 additional PPR observations, loosening the requirements on the times of observations, and reducing the size of surface bins from 10° to 9° square. This allows an increase in the surface coverage from 20% to nearly 50%. The team would compare the results of this refined analysis with a geologic map (Doggett et al., 2009) and a map of electron bombardment (Patterson et al., 2012), in order to test multiple hypotheses. The first hypothesis posits that thermophysical surface properties are dominated by geologic processes. Findings that thermophysical properties were relatively constant across bins of the same geologic unit and vary between bins of different geologic units would support this hypothesis. The second hypothesis holds that the thermophysical properties are dominated by electron bombardment. Findings that derived thermophysical properties were relatively constant across bins of similar bombardment and varied between bins with different levels of bombardment would support this hypothesis.

**2. BRIEF SUMMARY OF OVERALL EVALUATION:**

The proposed work would increase the resolution of important data products while correcting errors in earlier, lower-resolution versions of these products. The radiometer data would provide our only window into the thermal properties of Europa, and the PI is a leading authority on this dataset. However, the proposal did not justify how differences in thermal inertia are related to physical processes and how they would improve the body of knowledge. The proposal did not provide sufficient background and justification for how it would address limitations of the data. The proposal did not adequately justify the relaxation of the data lighting requirements from Rathbun et al., (2010), as well as the addition of 7 PPR datasets. The proposed work would be directly relevant to SSW. The proposed cost realism and reasonableness were appropriate.

### 3. INTRINSIC MERIT:

#### Major Strengths:

**The proposed work would increase the resolution of important data products while correcting errors in earlier, lower-resolution versions of these products.** The proposed work would correct previous work by the PI that was found to have been produced under an incorrect assumption about the change in incident sunlight with latitude. In addition, global coverage would be increased from ~20% to 50%. Furthermore, analysis and interpretation of the new data products would be improved by subsequent improvements in complementary products (i.e., new analysis of chaos regions to help establish the geological re-bins).

**The radiometer data would provide our only window into the thermal properties of Europa, and the PI is a leading authority on this dataset.** The planetary science community would benefit from maximization of the science from the limited Galileo data, and this proposal continued the PI's efforts to achieve this with PPR. The PI and collaborators would be uniquely qualified to accomplish the proposed work (e.g. collaborator Patterson is the first author on the cited electron bombardment work used in Task 2.)

#### Minor Strengths:

The determination of the maximum and minimum temperatures on Europa's surface would help with future instrument design. Additionally, the proposed work would inform selection of future targets for data collection in future mission design.

#### Major Weaknesses:

**The proposal did not justify how differences in thermal inertia are related to physical processes and how they would improve the body of knowledge.** The proposal selected Europa's chaos terrain and adjacent background plains for comparison with the distribution of thermophysical properties; however, despite the age difference of the two terrain types, there is no actual geologic process or hypothesized process discussed. The proposal did not discuss the geophysical implications of this measurement, or address important questions about how Europa works.

**The proposal did not provide sufficient background and justification for how it would address limitations of the data.** The proposal did not address how the presence of confounding factors would make the proposed analysis difficult, since the source data is so sparse and non-uniform. The proposal did not discuss the possibility of spurious correlations between thermal inertia and radiation or chaos. Furthermore, the limitations of the PPR data were not adequately addressed by the proposal. Galileo's radiometer data returns from Europa are limited, placing serious limits on their geophysical utility.

**The proposal did not adequately justify the relaxation of the data lighting requirements from Rathbun et al., (2010), as well as the addition of 7 PPR datasets.** The proposal did not adequately discuss how the relaxation of the requirements would affect the outcome of the proposed analysis [page 5] for each of the 3 Tasks.

**Minor Weakness:**

The instrument and the data analysis presented in the proposal would use a binning technique that further convolves the data. Because of the nonlinear relationship of infrared emission to temperature, the mean infrared emission would not reflect the mean properties of the surface.

The proposed work would be somewhat incremental over previous analysis of thermophysical properties of Europa. Furthermore, the results presented in Figure 4, right hand side, suggest that a substantial amount of the work for Task 1 has been done already, rendering questionable the advisability of funding that Task.

The proposal did not adequately discuss how the results of Tasks 2 and 3 would be interpreted. If the results for both geologic units and/or electron bombardment were found to be inconclusive, there was no discussion by the proposal as to how this would be interpreted. The proposal did not adequately justify its focus on chaos and plains material in Task 3.

The work plan did not provide sufficient detail on the time each task would take, and the kind of analysis for each task.

**Intrinsic Rating: Good**

**4. RELEVANCE TO SOLAR SYSTEM WORKINGS PROGRAM:**

**Major Strengths:**

**The proposed work would be directly relevant to SSW.** The proposal stated and demonstrated relevance to SSW objectives of characterizing and understanding the physical features of planetary surfaces and understanding processes that occur throughout the solar system. There is no other program that includes the analysis of data from the Galileo spacecraft, so it is uniquely responsive to SSW.

**Minor Strengths:**

The results of the proposed work would help with planning of instruments for Europa Clipper or other future missions to Europa. Additionally, the proposed work would assist in planning of future observations by targeting regions that warrant further study and would benefit from improved data coverage.

**Major Weaknesses:**

None noted.

**Minor Weaknesses:**

None noted.

**5. COST REALISM AND REASONABLENESS:**

**Major Strengths:**

**The proposed cost realism and reasonableness were appropriate.** Only the PI would be funded by the grant, and 3 collaborators will participate at no cost.

**Minor Strengths:**

None noted.

**Major Weaknesses:**

None noted.

**Minor Weaknesses:**

None noted.

**6. COMMENTS AND SUGGESTIONS FOR THE PI:**

The proposal never explicitly defined its use of the term ‘bin’. The term ‘bin’ was used differently for each of the three proposed tasks. Furthermore, the proposal stated that it would define “bins based on a process”, but this definition was not sufficiently described.