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Correction of Galileos Energetic Particle Detector, EPD, data and the effect on sputtering at Europa

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Abstract

Over the course of its 8-year mission the Energetic Particle Detector, launched in 1989 on the Galileo satellite, took data on the Jovian Particle environment. In the high radiation environment, the EPD composition measurement system became notably decayed; higher mass particles, specifically oxygen and sulphur, read far lower energies and count rates at later epochs in the missions. By considering the non-steady accumulation of damage in the detector, a correction method has been developed. Applying this correction method allows us to reanalyse the data. Specifically, we obtain new estimations on the surface weathering due to sputtering experienced by Europa and the other icy moons. Results of this allow for estimations of surface age relative to surrounding features, achievable using geological techniques.

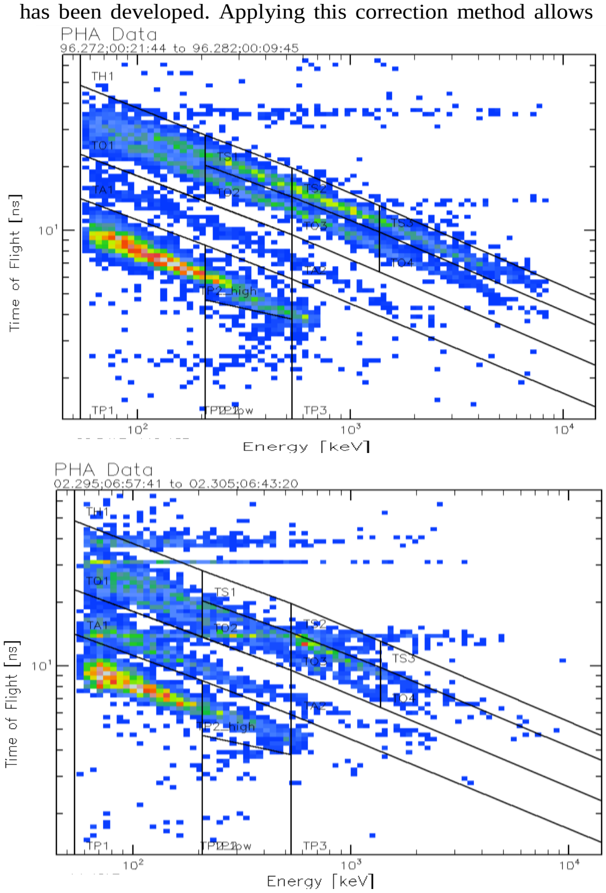

Figure 1: TOP: EPD data beginning on the 29th Sep 1996 shortly after the arrival of Galileo in the Jovian system. BOTTOM: EPD data beginning on the 22nd Oct 2002 nearing the end of the mission lifetime shortly before the demise of Galileo into Jupiter itself

1. Introduction

This paper focuses on the data from the EPD; specifically from the CMS telescope on the top of the instrument. Comparing data from the beginning of the mission to the final data retrieved (Figure 1) there is a clear discrepancy in the loci defining the elements. The uppermost is Sulphur followed by Oxygen beneath it, the faint line in the box labelled TA1 is Helium and the final loci, Protons.

The loci of these elements reveal that the detector is decaying in sensitivity. The amount of energy drop corresponds to the element in question; as a dead layer builds up on the front of the detector, the larger particles lose more energy passing through this layer than lighter elements. This thickening of the dead layer is caused by the radiation impacting onto the detector denaturing the sensitive volume.

By using the comparative count rates from relative locations in the Jovian system at different times, allows the calculation of a value for the decay in terms of counts hitting the detector. Systematically applying this value to the counts registered by the detector brings the values closer to the true values (Figure 2). (Full description of this work is in preparation.)

The correction results are dramatic, with the count rates greatly increased over the whole mission, particularly during the final years. The corrected data matches considerably better with calibration data, both for overall count rates and estimated dead layer thickness. It also fits well with ratioed data taken by Voyager across all elements [1].

2. Implications on Sputtering and Weathering rates at Europa

The key elements involved with the sputtering on the surface of Europa are Sulphur and Oxygen; these are the most effected by the dead layer and thus the correction.

The most common miss-allocation of the particles was a sulphur particle measured by the Oxygen channel. The nature

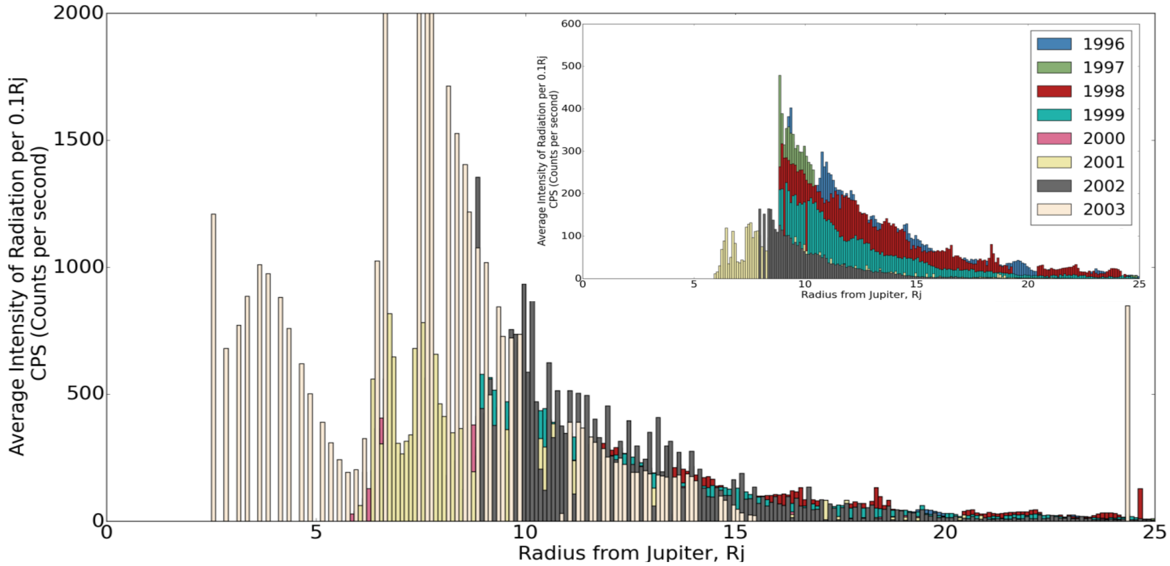

Figure 2: TOP RIGHT OVERLAY: Average count rate against radius for each year of the original TS1 Sulphur channel. MAIN IMAGE: Matching plot of corrected data from TS1 sulphur channel.

of the movement of the particles through the channels means that as the Sulphur channel increases by the correction, then the Oxygen must decrease with the correction. Overall the change is significant, meaning that sputtering on the surface is far more sulphur dominant than originally believed.

The aim of the paper is to determine the new erosion rates on the surface of Europa, and other moons, from using new higher flux rates of the environments energetic particles [2]. From simple estimations, this erosion should be significantly higher giving the possibility of being able to determine an age for the surfaces.

By using geological techniques such as cross cutting on images of the surface such as in Figure 3 it is possible to determine the older features from the newer formations on the surface. As the features accumulate there tends to be a flattening in the formations, the older the feature the less defined it appears to be [3]. By comparing this to well-studied erosion on Earth, wind erosion of ice sheets in the arctic for example, the amount of material removed can be estimated and a period can be established for the age difference in sections of the surface.

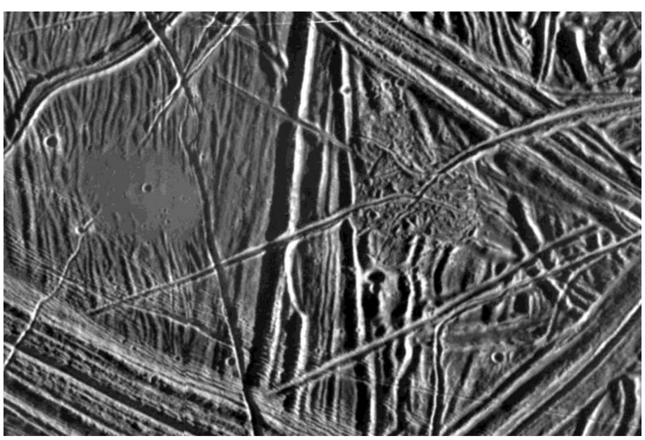

Figure 3: Image of Europa's surface taken by Galileo solid state imaging camera. From https://photojournal.jpl.nasa.gov

3. Summary and Conclusion

The correction of the EPD data is proving to be invaluable in re-evaluating the conditions on the surface of Europa. By calculating the surface erosion, a far more accurate estimate can be put on the age of the surface. Where others previously have only been able to estimate for global coverage, with this technique is may be possible to give dates to specific features and bridge time spans between main formation events.

4. Acknowledgements

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5. References

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