BRIGHT RAY CRATERS ON GANYMEDE OBSERVED FROM GALILEO AND VOYAGER IMAGES.

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Introduction: Ray craters are recognized to be the youngest feature on Ganymede [1], and represents the most recent impact cratering [2]. Also, being susceptible to destruction by various processes [1-3], ray craters may inform on the most recent geologic processes on Ganymede.

Passey and Shoemaker [4] identified 84 bright ray craters D>30 km and obtained several preliminary results and conclusions using the image data of Voyager. However, since Voyager 1 and 2 only have sufficient resolution (better than 2 km/pixel) images limiting to the subjovian and antijovian surroundings [4, 5], the analysis of Galileo images could fill in this gap. Also, the revised global geologic map [5] and advanced cratering impact model [2] make a more accurate distribution and a more comprehensive understanding of bright ray craters of Ganymede possible, which is the target of this study.

Data and Methods: We used the global image mosaic compiled from Voyager and Galileo images with a global resolution of 1 km/pixel to measure the locations and diameters of the ray craters and the related areas. The map is available via USGS Astrogeology Science Center. Also, since the crater rays are sensitive to solar illumination [2], we used the raw images of both Voyager and Galileo images (825 Voyager images and 314 Galileo images) to identify ray craters at high sun as much as possible. These images are available via Planetary Data System of NASA.

Considering the coverage and resolution of the raw images, we only measured the ray craters with D>10 km in the latitudinal range 70°N-70°S, and omitted the regions with resolution lower than 3 km/pixel [5]. Ultimately, our work resulted in a revised density distribution of bright ray craters corresponding to latitude, angular apex distance, and different terrain types.

Results: We identified a total of 257 ray craters D>10 km on 92% of the surface of Ganymede, which includes 188 craters from Voyager images and 69 from Galileo images, among them 67 craters on Dark Terrain and 190 on Bright Terrain.

Figure 1 shows the cumulative size frequency distribution (referred to hereafter as CSFD) of bright ray craters D>10 km on both Dark and Bright Terrain. It is obvious that for bright ray craters D<~100km, the density on Bright Terrain is systematically higher than that on Dark Terrain for ranging crater diameters, which is consistent with Passey and Shoemaker [4], suggesting

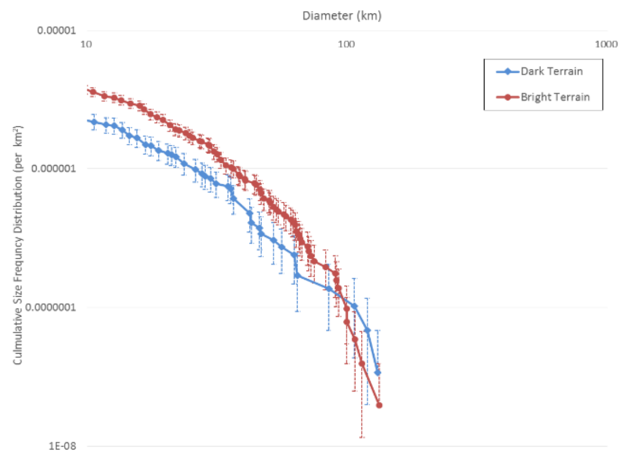

Figure 1. The cumulative size frequency distribution of bright ray craters on Dark Terrain and Bright Terrain, with density/√N error bars.

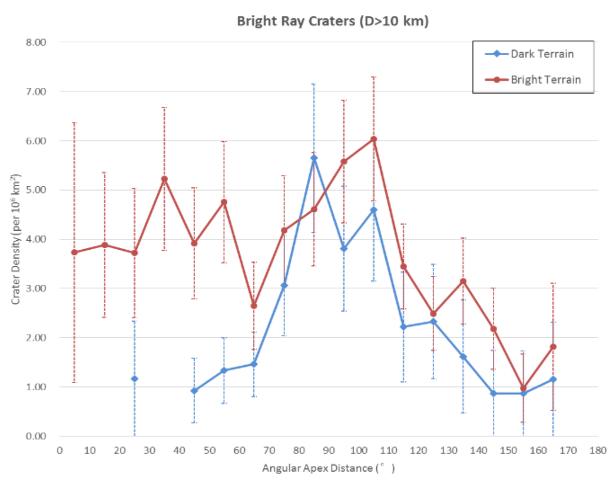

Figure 2. The density distribution of bright ray craters D>10 km with angular apex distance. The density is binned by every 10° , with density/√N error bars.

that crater rays are either more difficult to be produced or easier to be erased on Dark Terrain. In addition, big ray craters (D>100km) are very few (only 7 in number) and randomly distributed, resulting in a different CSFD curve for ray craters D>~100 km.

Figure 2 shows the distribution of bright ray craters D>10km as a function of the angular distance from the apex of motion. The density of bright ray craters on both Dark and Bright Terrain has a peak near apex distance of 80-110° (around prime meridian and anti-meridian). Also, bright ray craters on the Leading Hemisphere (referred to hereafter as LH) obviously has a higher density on Bright Terrain than on Dark Terrain.

In order to investigate the latitudinal dependency of bright ray craters, we plotted Figure 3a and 3b to show the density distribution of bright ray craters D>10 km with angular apex distance for different latitudinal ranges. On Bright Terrain (Figure 3a), two apex distance bins (60-70° and 100-110°) have continuous decrease with increasing latitudinal ranges, indicating that the bright rays are likely to be erased at a higher rate with increasing latitudes. On Dark Terrain (Figure 3b), many bins (50-60°, 80-100°, and 110-140°) have continuous decrease with increasing latitudinal ranges, which is similar to Figure 3a. Also comparing to Figure 3a, on the LH of Ganymede, there is a much lower

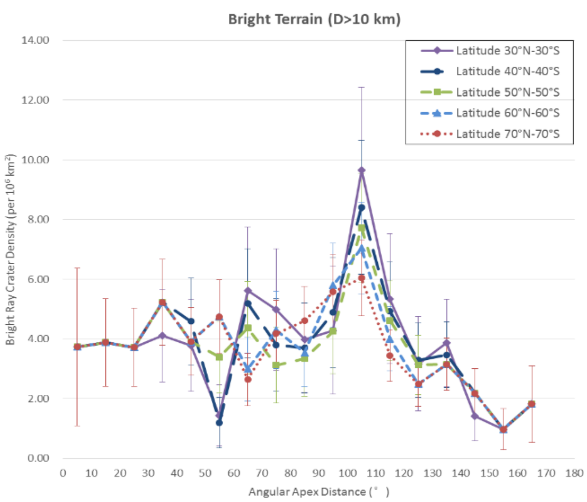

Figure 3a. The density distribution of bright ray craters D>10 km on Bright Terrain.

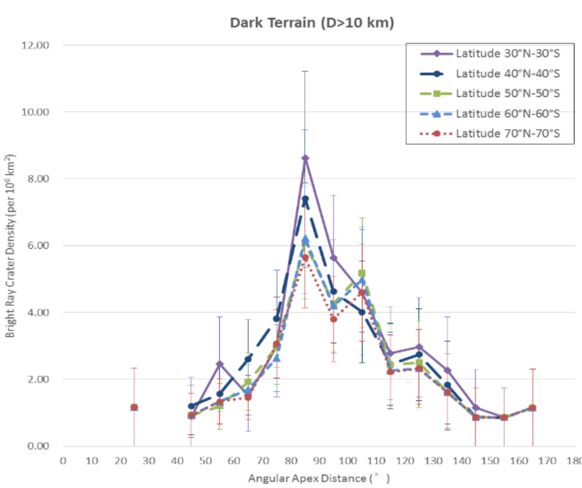

Figure 3b. The density distribution of bright ray craters D>10 km on Dark Terrain with angular apex distance for different latitude ranges. The density is binned by every 10°, with density/√N error bars.

density of ray craters on Dark Terrain than that on Bright Terrain for every corresponding latitudinal range.

Discussions: In general, ray craters are recognized to be created by recent impact cratering and erased by various geologic processes. The impact cratering rate is considered to be ~70x from apex to antapex based on prediction, but there is only ~4x observed on Bright Terrain [2]. In this study we consider the following processes that could erase bright rays including: micrometeorite gardening, thermal-driven sublimation and plasma-induced sputtering, the latter two of which are latitude related.

Based on our results, at high latitudes on Bright Terrain (reflected within apex distance 40-140° in Figure 3a), since sublimation processes is minor [6], sputtering is considered here to be the likely dominant process for ray erasure at high latitudes, which results in the continuous decrease with increasing latitudes. It is consistent with the boundary of polar caps of Ganymede, which is reportedly from the plasma bombardment and sputtering redistribution at high latitudes because the internal magnetic field of Ganymede strongly protects its equator region [7]. While on the LH of Ganymede, micrometeorite gardening as another important ray erasure process outweighs the sputtering process, making the density on LH lower than the peak near meridians.

At high latitudes on Dark Terrain (reflected within apex distance 40-140° in Figure 3b), the similar variations further indicate the influence of sputtering on bright rays, and for some of them at low latitudes, sublimation process may also help to enhance the variations. Due to the higher temperatures on Dark Terrain and especially at low latitudes, the higher sublimation rate there would accelerate the erasure rate of bright rays and help to make ray crater density overall lower on Dark Terrain than that on Bright Terrain (Figure 1). In addition, the higher sublimation rate on Dark Terrain works together with higher micrometeorite gardening on the LH of Ganymede might finally outweigh the production rate of ray craters on Dark Terrain and make the difference on the LH between the Dark and Bright Terrain.

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