# Study of Saturn's Ring System Observed from National Observatory, Nepal


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## Abstract

Fig.: Raw image of ringed planet Saturn observed from National observatory, Nepal


**A series of observations from October, 2009 are carried out using 16 inch Schmidt-Cassegrain Telescope located at National Observatory, Nepal. The ring system of Saturn is focused by over exposing the main body of the planet with webcam and CCD. In the first stage, variation of relative flux density is studied along the ring system. As a result, inhomogeneous variation in flux from the ring system is found due to variation in composition of the particles, and emission and absorption phenomena of the particles present in the ring system. More images are taken with different color filters to study its phase curves.**


## Saturn's Ring System

**Ring system resides within the planet in Roche limit. The vast majority of the particles comprising the rings have a albedo of 0.8. Their high reflectivity suggests the presence of icy content, confirming the major constituent of water ice and surface temperature of 70 K from the IR study. It is also found that the different rings have their different orbital periods (Julius Benton, 2005).**

**Table 1.3.** Saturn's ring system: basic data

| Name | Inner radius (km)* | Outer radius (km)* | Width (km)* |
|---|---|---|---|
| Ring D | 67,000 | 74,510 | 7,510 |
| Guerin gap | 74,510 | 74,658 | 148 |
| Ring C | 74,658 | 92,000 | 17,342 |
| Maxwell division | 87,500 | 88,000 | 500 |
| Ring B | 92,000 | 117,500 | 25,500 |
| Cassini's division | 117,680 | 120,600 | 4,800 |
| Huygens gap | 117,680 | 122,200 | ~4,520 |
| Ring A | 122,200 | 136,800 | 14,600 |
| Encke's complex | 126,430 | 129,940 | 3,500 |
| Keeler's division | 133,580 | 133,905 | ~325 |
| Ring F | 140,210 | 140,600 | ~390 |
| Ring G | 165,800 | 173,800 | 8,000 |
| Ring E | 180,000 | 480,000 | 300,000 |

*Distances are in kilometers from Saturn's center.

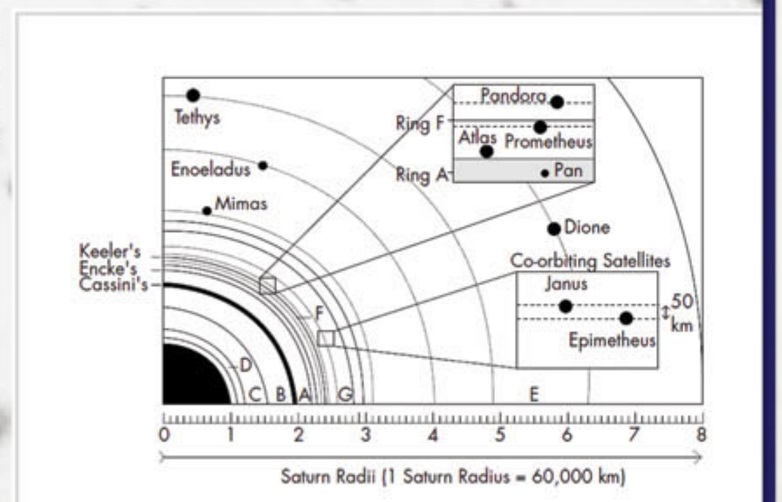
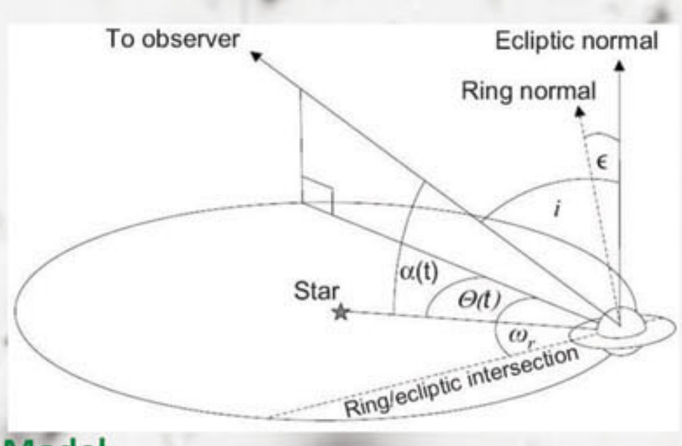



**Figure 1.15.** A detailed view of Saturn's rings. The view is high above Saturn's north pole looking down on the rings. (Credit: Julius L. Benton, Jr., ALPO Saturn Section.)




## Photometry

**A continuous data records of variations in the relative flux densities of ring system is useful for understanding the uniform relationship between brightness and the real albedo values. After taking a series of images and corresponding data of the ring system with a webcam and CCD, it is necessary to determine the visual magnitude. To illustrate the phase curve of Saturn's ring system, we are taking several images photo-electrically with different color filters on a sufficient number of nights so that the total flux becomes a well known function of phase angle.**

## Model

**The scattering of light by a cloud of particles and the shadow cast into the ring by foreground particles are the two major effects that are represented by the phase curves. Due to surface irregularities of the particles, it is quite difficult to analyze the scattering effect, but we can explain phase-flux variation to discuss the angular distribution of the light they scatter. For this work, we are expecting the nature of the phase curves to be identical before and after the opposition. We are trying to model the reflected brightness of Saturn's ring system by tracing out how light rays from the Sun are reflected by each position on the rings. We are assuming that the reflected rays collected by us are parallel that only incorporates the reflection from the rings but not second order effects such as planet shine on the rings. The rings brightness at each position is the function of three angles( $\mu_0, \mu, \alpha$ ), optical depth and the albedo so that the normalized brightness is given by,**

$$P(\mu_0, \mu, \alpha) \equiv I(\alpha, \mu_0, \mu)/(F\mu_0)$$

**where $\mu_0$ is the cosine of the incidence angle measured from the local vertical, $\alpha$ is the phase angle and $F\mu_0$ is the ideal reflected brightness of the isotropically scattering surface.**

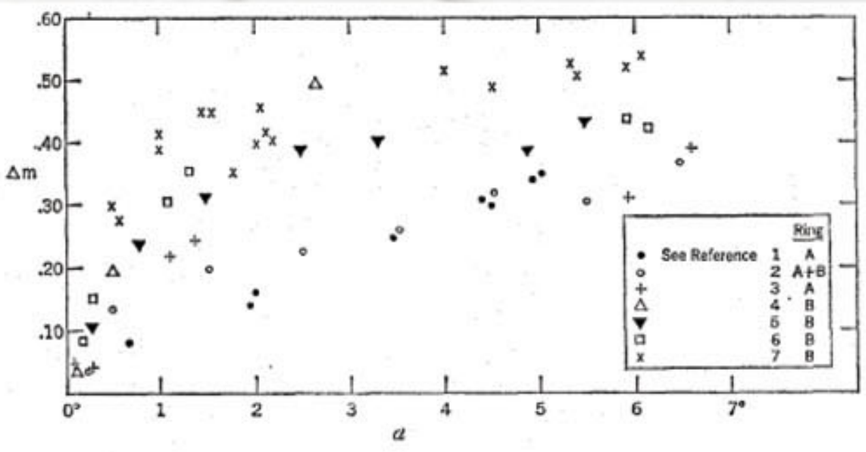



FIG. 1. Published phase curves of Saturn's rings, after Bobrov (1954).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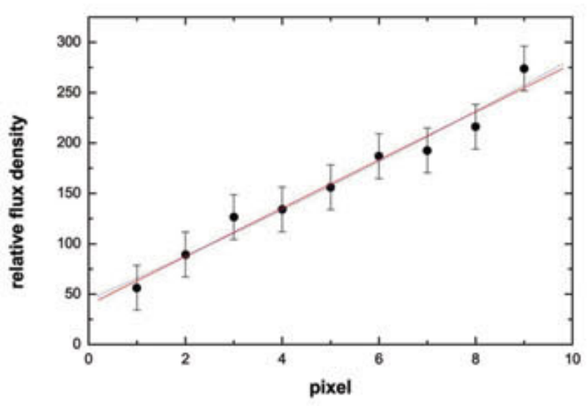
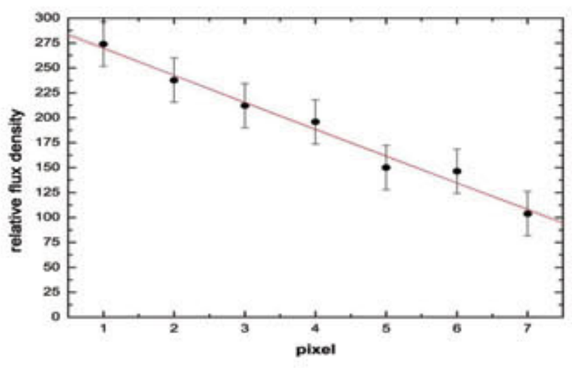
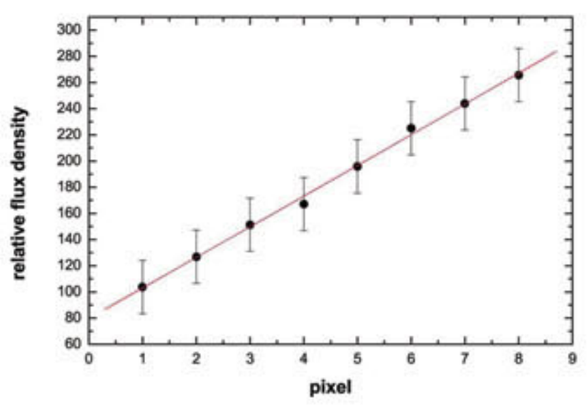
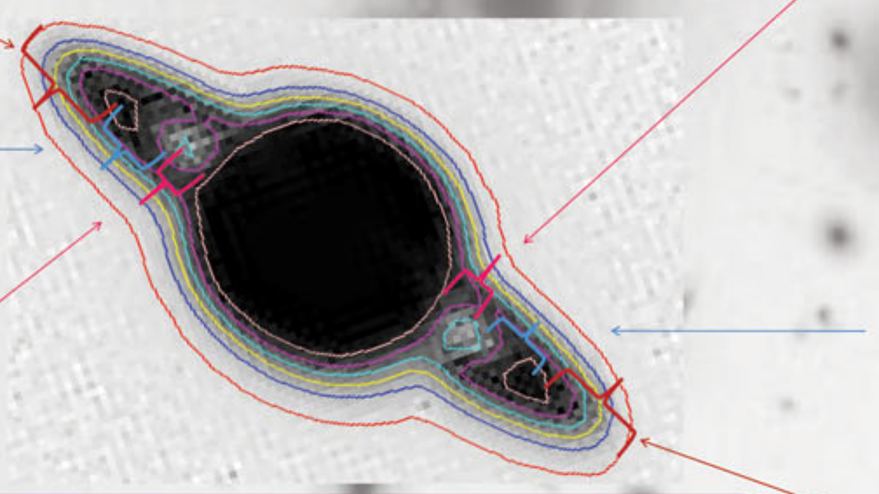
## Preliminary Results



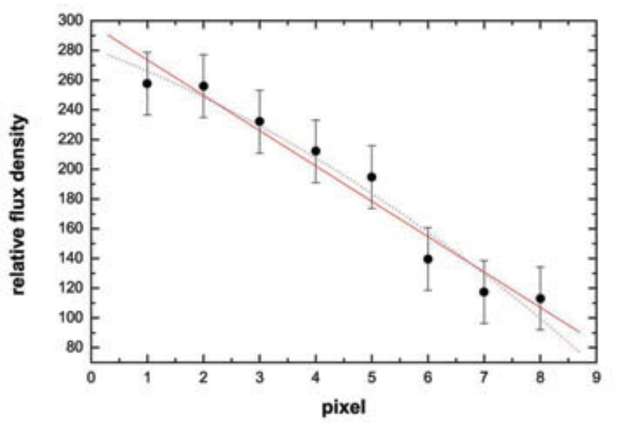



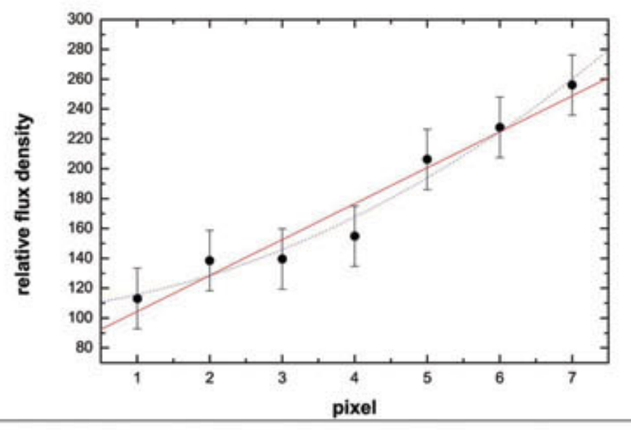



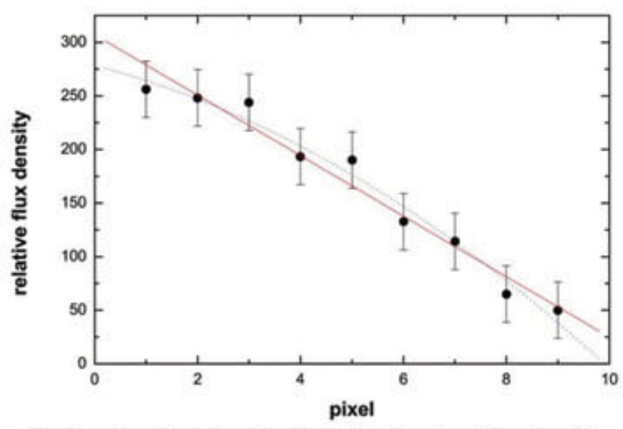

**Flux emitted from the ring system is found to be inhomogeneous in both eastern and western parts which is due to different reflective nature of different rings. Steady increase and then decrease and again increase in the flux is observed as there are seven major rings , of which rings A and B are the brighter as compared to other rings. In addition, values of slopes are found to be almost same for the both eastern and western parts of the ring system.**

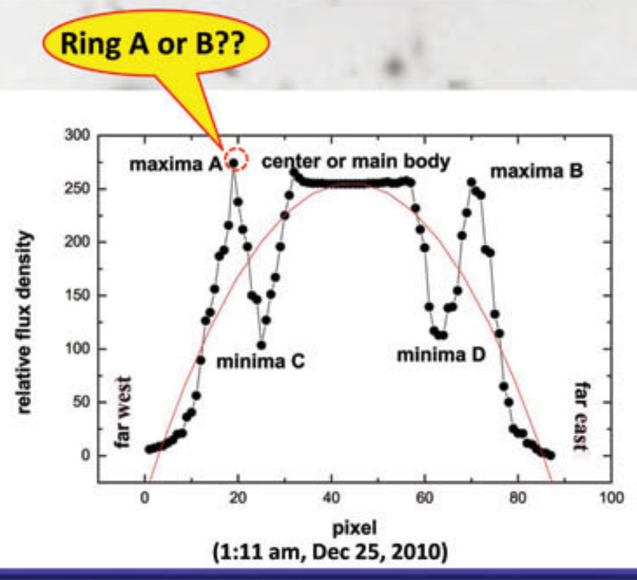


**Possible reasons for the variation in flux along the ring system can be as follows: incident angle of the rays coming from rings, phase angle of the planet, rings opacity, values of albedo, and scattering and absorption phenomena of the particles present in the rings.**



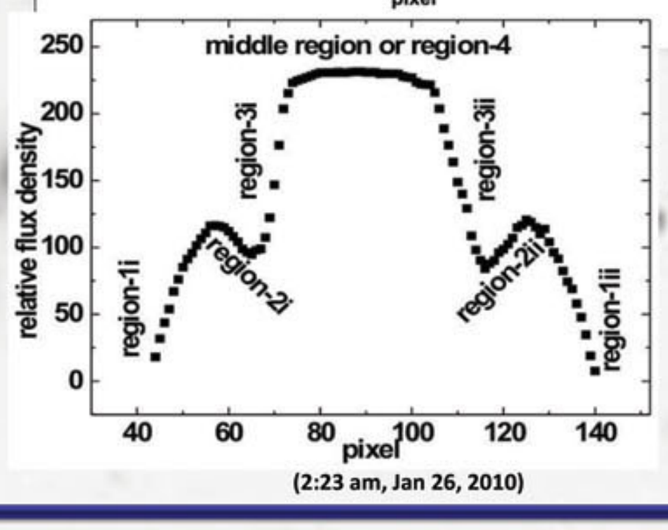




**Results from the observations in early and late 2010:**

**Variation in relative flux density is almost similar in both observations, but in December sharp peaks are observed. This could be due to change in geometry of the rings around the planet. Slopes are found to be almost of same values for both the observations.**




## Works on progress

- **Taking more images of rings with different color filters to study phase curves.**
- **Trying to model the nature of variation in flux emitted from rings with phase angles.**
- **Side by side , we are also observing supernovae to study their light curves .**

## References & Acknowledgements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Fermi/Swift GRB Conference, May 7 – 11, 2012, Munich, Germany