Abstract

The minor bodies in the solar system comprise of asteroids, comets, trans-Neptunian objects, dwarf planets, planetary satellites, the Trojans of the giant planets, Centaurs and Kuiper belt objects. The widely accepted solar-nebula hypothesis for the formation of the solar system suggests that these minor bodies along with all the other planets formed within a disk of gas and dust called the proto-planetary disk. Formation of planets and their subsequent migration within the disk led to redistribution of the smaller bodies and formation of their various reservoirs at different distances from the Sun. Although a large number of ground based observations coupled with various space based missions have led to an advancement in our understanding of the formation of the solar system, a lot of questions about the composition of the small bodies, their dynamic behaviour, source location and formation scenarios are yet to be completely understood.

Due to their volatile nature, comets tend to become active as they move closer to the Sun. The various kinds of ices present in the cometary nucleus start to sublimate at various temperatures at different heliocentric distances. The gases formed due to sublimation along with the dust particles forms the coma of the comet. This mixture of gas and dust arises from the icy volatile material which was trapped in the cometary nucleus ever since its formation in the proto-planetary disk. This makes them the signature bodies to understand the formation of the solar system.

Comets carry a significant amount of pristine material from the early solar system and are relatively bright objects which can be observed and studied using even one meter class telescopes. Therefore the current work has focused on studying comets and near-Earth asteroids on comet like orbits. Optical spectroscopic studies of these objects have been carried out using the 0.5 m and 1.2 m telescopes at the Mount Abu Infra-red Observatory with an aim of contributing towards answering some of the questions in cometary and solar-system science.

A plethora of emission lines are seen in the optical spectrum of a comet. These arise

due to the fluorescence excitation of the various molecular and ionic species of the gases present in comet's coma. In this work, we have monitored the activity in different comets by spectroscopically observing them at various heliocentric distances.

The thesis starts with a basic introduction to the minor bodies of the solar system, the effects of migration of giant planets on the distribution of these small bodies, the physical properties and classification of comets and asteroids and the optical spectrum of these objects. The facilities used for observations and the data reduction techniques have been described briefly. The low resolution spectrograph LISA has been used to obtain the optical spectrum of different comets and asteroids. The optical spectrum of comet C/2014 Q2 (Lovejoy) was obtained at four epochs in 2015. The comet showed a lot of molecular emissions in its spectrum. The production rates, production rate ratios, dust production and dust to gas ratio was estimated for this comet and its trend with the heliocentric distance was studied. On the similar lines, optical spectra were obtained for three more long period comets: C/2013 US10 (Panstarrs), C/2013 X1 (Panstarrs), C/2015 V2 (Johnson) and two short period comets: 41P/Tuttle–Giacobini–Kresák and 45P/Honda–Mrkos–Pajdušáková. The fall in production rates of these comets with heliocentric distances have been examined. The comets 41P and C/2015 V2 have also been imaged using the Hale-Bopp Narrow band filters. Comet C/2016 R2 showed an unusual spectrum, quite different from the general cometary spectra. An in depth analysis of the optical spectrum of this comet has been carried out. First comet observations with the Hanle Echelle Spectrograph at the 2m Himalayan Chandra Telescope were done during the course of this work. The near Earth asteroid 2014 JO25 was spectroscopically followed during its close flyby of Earth in April 2017. A significant range of phase angle was covered during the observations of this asteroid. Results from these observations have also been discussed.

Most of the observations have been carried out using smaller class of telescopes and a small spectrograph. This demonstrates and exemplifies the importance of small telescopes and ground based observations of minor bodies of the solar system.