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Low resolution optical spectra of Jupiter family comets 41P/ and 45P/

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Abstract

A typical optical spectrum of a comet with well developed coma shows molecular emissions dominated by carbon chain molecules. The Jupiter family comets 41P/Honda–Mrkos–Pajdušáková and 45P/Tuttle–Giacobini–Kresák were spectroscopically observed using the 0.5m telescope at the Mount Abu Infra-red observatory during the period of December 2016 to May 2017. The optical spectra of these comets were obtained using the low resolution spectrograph (LISA) mounted on the telescopes at Mount Abu. As expected in the optical region,the comets exhibited a lot of molecular emission bands including CN,C2,C3,CH and NH2. The spatial profiles of some of these molecules were studied using the traditional theoretical model given by Haser. The low productions rates estimated for these comets indicate an extensive processing of the comet nucleus.

1 Introduction

Comets are cold icy bodies in the solar system that were formed in the solar nebula and are considered to be the signature bodies to understand the formation of the solar system. Cometary molecular emissions are well known and have been studied since a long time. A typical optical spectrum of a comet with well developed coma shows molecular emissions [Kumar et al., 2016] dominated by carbon chain molecules like C_2 and C_3. NH_2 and CN are two other species which show prominent emission lines in the optical spectrum.

These emissions are a result of fluorescing daughter products which are generally produced from photodissociation of the parent species sublimating from the nucleus. Many of the parent species of these products are yet to be confirmed. Results from Rosetta spacecraft have revealed exciting processes that takes place in a cometary nucleus. However, it is vital to observe and study comets in different orbits, to get an overall picture of their formation and evolution. In this work, we have observed and analysed the optical spectra of two Jupiter family comets 41P/ and 45P/.

2 Observations and Reductions

The observations were carried out with LISA spectrograph mounted on the 0.5 m(f/6.8) telescope (PlaneWave Instruments CDK20) at the Mount Abu Infra-red observatory (MIRO), Mount Abu, India. The sky conditions were photometric during the observing period.

Table 1: Observational Log

Comet	Date	Heliocentric Distance r_h (AU)	Solar Phase (degrees)	Exposure (Seconds)
41P/	19/04/2017	1.04	70	400
45P/	09/01/2017	0.56	130	1200

Details of the comet observations are given in table 1. The exposure times mentioned in the table are for each individual frame. A more detailed description of the instrument LISA is given in Kumar et al. [2016]. The slit was placed at the photo-center of the comet and was manually tracked through the guiding CCD throughout the exposure time. The observations were made using the scheme, sky-object-sky, for the proper background sky subtraction.

3 Results and Conclusion

Both the Jupiter family comets exhibited a lot of molecular emissions in their spectra. The optical spectra of the comets are shown in figure 1. The column density profiles for C_2 and CN were obtained for both the comets by integrating the flux at various

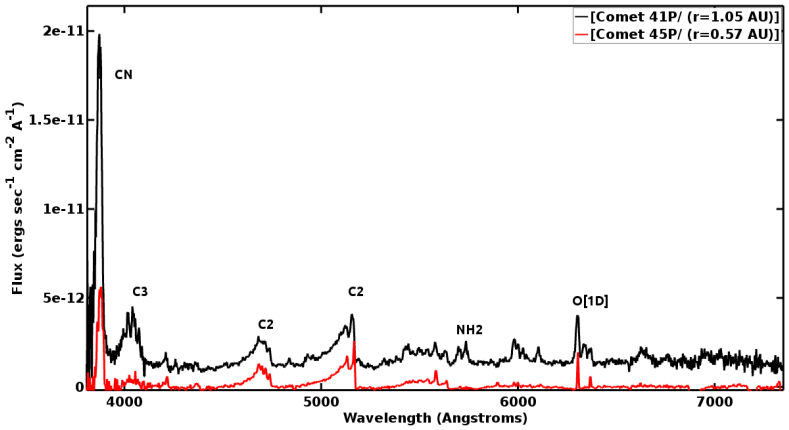

Figure 1: Optical spectra of comets 41P/ and 45P/ obtained from using LISA spectrograph on the 0.5m telescope at the Mount Abu Infra-red observatory, India

. These profiles were then fitted using the standard Haser model. The C2/CN ratio differs significantly in both the comets. This is due to relatively low emissions from CN radical in comet 45P/. Pressuming that HCN is the dominant parent of CN in comets, our results are in accordance with the fact that HCN has been found to be highly deplted in comet 45P/ DiSanti et al. [2017]. The production rates of these molecular species calculated for comet 41P/ turns out to be of the order of about 10^{21} molecules per second.

This is extremely low, as compared to the production rates seen in the Oort cloud comets. This could be due to excessive processing of the volatiles of the Jupiter family comets, due to extremely short orbits and subsequent frequent exposure to high density solar flux impinging the comet surface. Therefore, the low production rates can also be a result of low volatile content in the subsurface of the comet. There have been many instances of outbursts of short period comets [Ishiguro et al., 2016; Pajola et al., 2017]. Although, these molecular emission bands are daughter and grand-daughter products, the behavior of their production rates and scale lengths strongly depends on the parent molecules. The parent molecules originate in the surface layers of the cometary nuclei. They are influenced by many of the orbital parameters like perihelion and aphelion distances and orbital period, inclination, etc. Both of these low inclination Jupiter family comets have close resemblance (in terms of orbital parameters) to the short-period comet 67P/Churyumov–Gerasimenko studied in detail by Rosetta. Therefore, their study gives vital confirmation on the similarity or otherwise of the Jupiter family comets.

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References

DiSanti, M. A., Bonev, B. P., Dello Russo, N., et al. 2017, Hypervolatiles in a Jupiter-family Comet: Observations of 45P/Honda-Mrkos-Pajdušáková Using iSHELL at the NASA-IRTF, AJ, 154, 246

Ishiguro, M., Kuroda, D., Hanayama, H., et al. 2016, 2014-2015 Multiple Outbursts of 15P/Finlay, AJ, 152, 169

Kumar, V., Ghetiya, S., Ganesh, S., et al. 2016, Optical spectroscopy of comet C/2014 Q2 (Lovejoy) from the Mount Abu Infrared Observatory, MNRAS, 463, 2137

Pajola, M., Höfner, S., Vincent, J. B., et al. 2017, The pristine interior of comet 67P revealed by the combined Aswan outburst and cliff collapse, Nature Astronomy, 1, 0092