OPPORTUNITIES FOR IN-DEPTH COMPOSITIONAL STUDIES OF SHORT-PERIOD COMETS: SUMMARY FROM SEMESTER 2017A OBSERVATIONS AND PROSPECTS FOR A 2018 OBSERVING CAMPAIGN.

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Introduction: The period from late 2016 to early 2019 represents the best opportunity in decades to conduct studies of known short-period (ecliptic) comets, featuring five available targets, with three of these making close approaches to Earth (within 0.1 AU) and two having perihelia well within 1 AU. Our team combines high resolution IR and optical spectroscopy from ground-based telescopes to conduct compositional studies of volatiles in the cometary coma.

Previous observations: The first half of 2017 provided extremely rich observational opportunities. Three ecliptic comets – Jupiter-family comets (JFCs) 45P/Honda-Mrkos-Pajdušákova and JFC 41P/Tuttle-Giacobini-Kresak, plus dynamically evolved 2P/Encke – experienced highly favorable apparitions.

In the IR, very long on-source integration times were accumulated on these three comets with the powerful new high-resolution, cross-dispersed spectrograph, iSHELL, at the IRTF [1] and, in the case of 45P and 41P, also with NIRSPEC at Keck II. This enabled determining accurate production rates for H_2O, production rates and abundance ratios relative to H_2O for multiple trace parent volatiles (i.e., molecules housed as ices in the nucleus), and also conducting spatially resolved studies of coma physics (rotational temperatures and column abundances of H_2O).

The availability of iSHELL coupled with the daytime observing capability at the IRTF has opened a powerful window for detailed compositional studies of comets over a range of heliocentric distances (R_h), particularly at small R_h where studies are relatively sparse. Our campaign provided robust measures of the "hyper-volatiles" CO and CH_4 in 45P ([2]; see Figure 1) and 2P [3, 4]. Both molecules are substantially under-represented in compositional studies of ecliptic comets.

Optical spectra provided measures of photodissociation product species using the Tull Coude spectrograph at McDonald Observatory and the ARCES spectrograph at Apache Point Observatory.

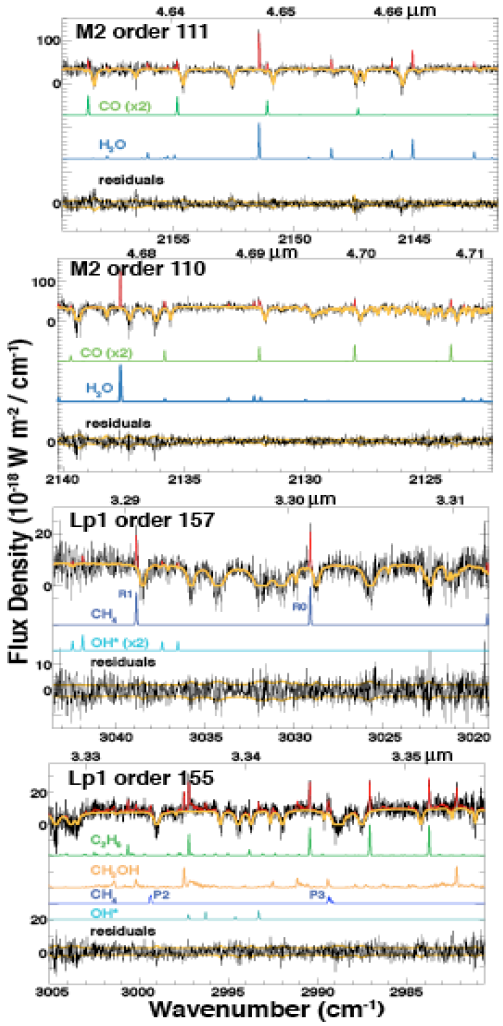

Figure 1. IRTF/iSHELL spectra of comet 45P/Honda-Mrkos-Pajdušákova in two echelle orders within each of two instrument settings (M2 and Lp1), showing detections of the "hyper-volatiles" CO and CH_4 near 4.7 and 3.3 μm, respectively. Fluorescence models of molecular emissions are offset below each spectrum. Top panels: CO co-measured with H_2O. Bottom panels: CH_4 and OH prompt emission (OH*, a well established proxy for water production) together with additional organic molecules. (Adapted from Reference [2].)

When possible optical and IR observations were obtained contemporaneously, with the goal of addressing potential parent-product relationships. We will summarize our 2017 campaign, and highlight related ongoing work.

Planned Future Observations: In the near future (between July 2018 and February 2019), JFCs 21P/Giacobini-Zinner and 46P/Wirtanen will have highly favorable apparitions. Comet 21P has higher gas production than most JFCs, and it will become the first comet for which compositional studies using high-resolution IR spectroscopy will have spanned three separate orbital epochs (perihelion passages), the two previous ones being in 1998 ([5],[6]) and in 2005 [7]. Comet 46P was the original target of the European Space Agency's Rosetta mission that recently completed its successful rendezvous with and detailed study of 67P/Churyumov-Gerasimenko. In December 2018, 46P will remain close to Earth (within $\Delta = 0.1$ AU) for several weeks, and a coordinated world-wide observing campaign is being organized to study its activity [8]. Observational prospects for our team will be discussed, including capabilities for serial studies (i.e., measurements at multiple R_h).

Acknowledgements. This work is supported through the NASA Planetary Astronomy/Solar System Observations Programs, the NASA Planetary Atmospheres/Solar System Workings Programs, the NASA Astrobiology Program, the NSF Solar and Planetary Research Program, the NASA-Postdoctoral Program, and the NASA Earth and Space Science Graduate Fellowship Program.

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