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A Spectral Survey of Jupiter-Family Comets at Infrared Wavelengths

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Abstract

We summarize our high-resolution infrared survey data on Jupiter-family comets with emphasis on 73P/Schwassmann-Wachmann 3, 17P/Holmes and 103P/Hartley 2. These comets are emphasized because (1) they are chemically different and (2) they had the most favorable observing circumstances resulting in many strong spectral emission features.

1. Introduction

A primary goal of planetary science is to determine conditions present during the formation of the solar system. The study of comets may provide the most direct link as they are thought to be the least processed bodies from the birth of the solar system, so their present compositions may closely reflect conditions from that time. Measurements at multiple wavelengths have revealed a great diversity in the chemical composition of comets through the determination of relative production rates of gas species in the coma. While relative abundances provide a chemical summary of identified and well-characterized species, spectral surveys provide the detailed characteristics both of what is known and what is unknown. Spectral comparisons illustrate compositional differences and the relationship between species in comets, through comparisons of relative line intensities. However, a survey of comet C/1999 H1 Lee revealed that about 20% of all detected lines in the 2.9 – 3.7 μm region were unidentified [1]. Because the comet population is diverse, comparison of survey spectra can provide a valuable first step to identifying unknown emissions in cometary spectra. For comets with bright emission lines, spatial profiles of unknown emission features can provide further clues as to the identity of these features.

2. A brief summary of the database

Table I summarizes our survey data on Jupiter family comets, with those in bold emphasized in this paper. All survey data were obtained from the NIRSPEC spectrometer [2] on the Keck II Telescope on the summit of Mauna Kea, Hawaii. The spectral coverage obtained for each comet is illustrated in Figure 1.

Table I: Jupiter family comets in our survey database

Comet	UT Date	R (AU)	Δ (AU)	Δ_{dot} (km/s)
9P/Tempel 1	7/4/05	1.506	0.894	+9.2
73P/SW3-B	**5/14/06**	**1.005**	**0.067**	**+0.3**
73P/SW3-C	5/14/06	1.000	0.081	+3.0
17P/Holmes	**10/27/07**	**2.450**	**1.629**	**-3.0**
6P/d'Arrest	8/11/08	1.354	0.354	+0.7
103P/Hartley 2	**11/4/10**	**1.064**	**0.156**	**+7.0**

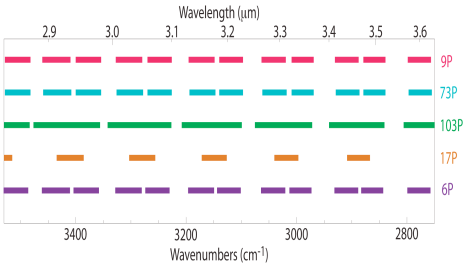

Figure 1: The spectral coverage for survey comets.

3. Results

We compare characteristics of comets in different spectral regions and discuss insights that can be obtained. We show compositional differences and the relationship between species in comets through detailed spectral comparisons. An example for the 3.025 – 3.035 μm spectral region is given in Fig. 2. To more fully illustrate spectral diversity, we compare the spectra three Jupiter-family comets with two long-period comets in Fig. 2. We also look for clues to the identity of unknown emission features seen in spectral surveys through comparisons between comets of different compositions coupled with spatial distributions of these unknown emissions.

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References

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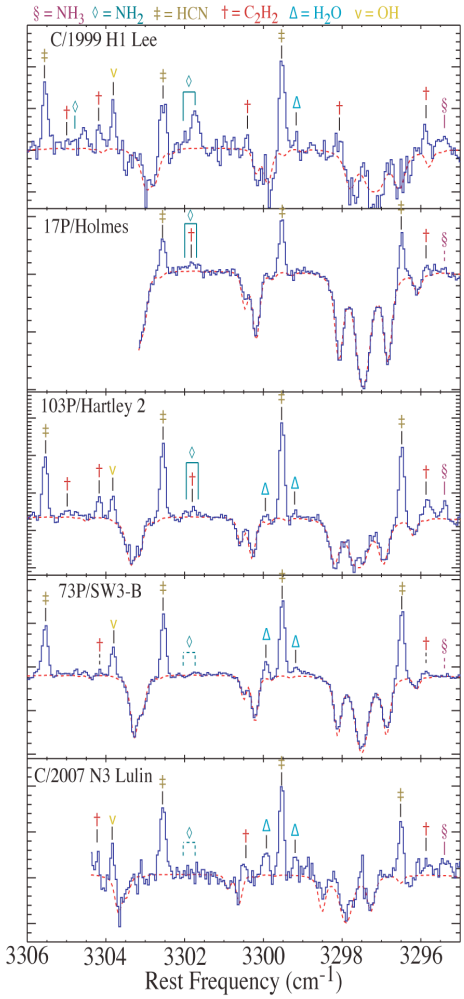

Figure 2: A comparison of five comets in a limited spectral region (note that these spectra represent a very small percentage of our total spectral coverage in Fig. 1). Note the clear compositional differences reflected in the relative line intensities in these comets.