AN EMERGING TAXONOMY FOR COMETS BASED ON ORGANIC PARENT VOLATILES: IMPLICATIONS FOR DYNAMICAL AND CHEMICAL PROCESSES IN THE PROTO-PLANETARY DISK. M. J. Mumma[1], M. A. DiSanti[1], B. P. Bonev[1,2], G. L. Villanueva[1], K. Magee-Sauer[3], and E. L. Gibb[4]
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Comets today reside in two distinct reservoirs, the OC and the KB region (divided into the classical KB, the scattered disk, and the detached or extended disk populations). Comets injected into the inner planetary system are classified dynamically as isotropic (LPC or HTC) or ecliptic (Centaur-type, Encke-type, or JFC). Ecliptic comets come from the KB reservoir while the isotropic comets come from the Oort cloud [1]. All except Centaur-type comets have the potential of becoming sufficiently bright to obtain sensitive detection limits through high-resolution NIR spectra.

Comets likely formed at diverse distances from the young Sun, ranging from just outside the nebular "frost line" ($R_h \sim 5$ AU) to distances beyond 100 AU. Until recently, it was thought that most JFCs formed in the Kuiper-belt region ($R_h > 30$ AU) while OCs formed in the giant planets' region (5-30 AU) of the protoplanetary disk, implying these two dynamical populations should have distinct native ice compositions due to strong radial variations in temperature and other conditions in the proto-planetary disk [2,3].

However, a new paradigm emerged in 2005 (the "Nice" model) [4,5]. This model predicts that comets formed in the outer proto-planetary disk (beyond $R_h \sim 17$ AU) entered both the OC and the Kuiper disk, though likely in different proportions [6,7]. Comets formed in (and ejected from) the giant-planets' feeding zones (5 - 14 AU) probably entered the outer disk [8], and its subsequent disruption contributed some of the mass impacting Earth during the late heavy bombardment [**Error! Bookmark not defined.**].

The Nice model predicts compositional diversity among both OC and JFC dynamical populations, with likely no well-defined delineation between the two groups (see below). Our measurements support this view, even within the relatively small sample of comets we measured.

A sample of 14 comets shows three distinct groups based on organic composition (Table 1). Six OC comets form the dominant group, with tightly grouped abundances for four parent molecules. Our sample also includes two comets with enriched abundances, with one belonging to the OC group and one a JFC. Severely organics-depleted comets also draw from both dynamical reservoirs. 8P/Tuttle is peculiar.

The detection of an OC comet that likely formed in the Jupiter-Saturn region [9] (C/1999 S4 LINEAR) demonstrates that OC comets today provide key insights into organic chemistry in the giant-planets' region of the proto-planetary disk and dynamical transport to specific reservoirs. **With improved statistics, we expect to provide important constraints on dynamical mixing into the two principal reservoirs**.

No.	Name	Orbit[a]
1	C/2001 A2 (LINEAR)	LPC (OC)
2	17P/Holmes	JFC (KB)
3	C/1996 B2 (Hyakutake)	LPC (OC)
4	C/1995 O1 (Hale-Bopp)	LPC (OC)
5	C/1999 H1 (Lee)	LPC (OC)
6	153P/Ikeya-Zhang	HTC (OC)
7	1P/Halley	HTC (OC)
8	C/2004 Q2(Machholz)	LPC (OC)
9	9P/Tempel1 (ejecta) [d]	JFC (KB)
10	9P/Tempel1 (ambient)[d]	JFC (KB)
11	8P/Tuttle	HTC (OC)
12	C/2001 WM_1 (LINEAR)	LPC (OC)
13	C/1999 S4 (LINEAR)	LPC (OC)
14	73P/S-W 3-C[e]	JFC (KB)

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