

## Comet C/2012 S1 (ISON)'s carbon-rich and micron-size-dominated coma dust

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Comet C/2012 S1 (ISON) was unique in that it was a dynamically new comet derived from the Nearly Isotropic Oort cloud reservoir of comets with a sun-grazing orbit. We present thermal models for comet ISON ( $r_h \sim 1.15$  au, 2013-Oct-25 11:30 UT) that reveal comet ISON's dust was carbon-rich and dominated by a steep (and therefore narrow) grain size distribution (GSD) dominated by  $\sim$  micron-sized grains. We constrained the models by our SOFIA FORCAST photometry at 11.1, 19.7 and 31.5  $\mu\text{m}$  and by a silicate feature strength of  $\sim 1.1$  and an 8–13  $\mu\text{m}$  continuum greybody color temperature of  $\sim 275$ – $280$  K (using  $T_{bb} \propto r_h^{-0.5}$  and  $T_{bb} \sim 260$ – $265$  K from Subaru+COMICS, 2013-Oct-19 UT) [1,2]. Spectra of comet ISON with IRTF+BASS (2013-Nov-11-12 UT) also show a silicate feature strength of  $\sim 1.1$  as well as an 11.2  $\mu\text{m}$  forsterite peak [3]. Our thermal models [6], which employ 0.1–1000  $\mu\text{m}$  grains, yield constraints for the dust composition as well as GSD parameters of slope, peak grain size, porosity: ISON's dust has a low silicate-to-amorphous carbon ratio ( $\sim 1:9$ ), the GSD has a steep slope ( $N \simeq 4.5$ ), a peak grain radius of  $\sim 0.7$   $\mu\text{m}$ , and moderately porous grains. Specifically, the 8–13  $\mu\text{m}$  continuum color temperature implies submicron-to-micron-size grains and the steep fall off of the SOFIA far-IR photometry requires the GSD to have fewer relative numbers of larger and cooler grains compared to smaller and hotter grains. A IR proxy for the dust production rate is  $\epsilon f \rho \sim 1500$  cm [4], which is akin to but larger than  $A f \rho$  in scattered light (2013-Oct-20 UT,  $A f \rho = 796$  cm ( $\pm 5\%$ ) in V-band from Swift) [5]. Also, ISON had a moderate-to-low dust-to-gas ratio [6]. Comet ISON's dust composition and GSD properties are distinct from the few well-studied long-period Nearly Isotropic Comets (NICs) that all had 'typical' GSD slopes ( $3.4 \leq N \leq 3.7$ ) and silicate-to-amorphous carbon ratios  $\gg 1$  as well as the following properties: C/1995 O1 (Hale-Bopp)[7,8,9,10] and C/2001 Q4 (NEAT)[11] had smaller and highly porous grains, whereas C/2007 N4 (Lulin)[12] and C/2006 P1 (McNaught)[13] had larger and compact porous grains. Radial transport to comet-forming disk distances ( $\geq 20$  au) is easier for smaller grains than for larger grains ( $\leq 1$   $\mu\text{m}$  vs.  $\sim 20$   $\mu\text{m}$ -like Stardust terminal particles) [14]. Perhaps Comet ISON formed either earlier in disk evolution whereby larger grains did not have the time to be transported to distances beyond Neptune, or the comet formed so far out in the disk that larger grains did not traverse such large radial distances. The high carbon-content of ISON's refractory dust appears to be complimented by the presence of limited-lifetime organic (CHON-like) grain materials: preliminary analyses of near-IR and high-resolution optical spectra indicate that gas-phase daughter molecules  $\text{C}_2$ , CN, and CH were more abundant than their parent molecules (HCN,  $\text{C}_2\text{H}_2$ ,  $\text{C}_2\text{H}_6$ , measured in the near-IR) [15]. Dust composition as well as grain size distribution parameters (slope, peak grain size, and porosity) give clues to comet origins [16,17].

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