EXPLORING THE RELATIONSHIP BETWEEN THE COMPOSITION AND SIZE OF COMETARY NUCLEI. J. E. Robinson[1], U. Malamud[2], C. Opitom[1], H. B. Perets[2], J. Blum[3]. [1]The University of Edinburgh, Edinburgh, UK (james.robinson@ed.ac.uk), [2]Israel Institute of Technology, Haifa, Israel, [3]Technische Universität Braunschweig, Braunschweig, Germany

Introduction: A recent study by [1] found that the generally accepted pebble structure of cometary nuclei would have an extremely low thermal conductivity. This means that radiogenic heating, which is dependent on the size of a nucleus, can lead to higher temperatures within the nucleus than previously considered. For comets of sufficient size this heating leads to a thermal gradient and internal transport of volatile species, either depleting the nucleus or leading to a shell-like distribution of volatiles. The internal differentiation of hyper/super-volatile species implies that we should observe greater abundances of these species in larger cometary nuclei. Here we present the preliminary results of our investigations into the relationship between the composition and size of cometary nuclei.

Literature Data Search: We have conducted a wide search for literature sources of cometary compositions and nuclear sizes and compiled these measurements into a single unified database. Cometary composition can be estimated from observations of the coma which is driven by sublimation of volatiles in the nucleus due to solar radiation heating. For most comets remote spectroscopic observations and narrowband photometry (e.g. [2], [3]) are used to measure emission features of volatile species and obtain production rates. In-situ measurements via spacecraft mission are rare but offer more accurate assessments of composition (e.g. ROSINA mass spectroscopy from the Rosetta mission [4]). The relative abundance of a species can be assessed by comparison to the production rate of the most abundant cometary volatile, H2O. In contrast, the size of cometary nuclei is inherently difficult to measure. Typical cometary nuclei are small and dark, often only observable when the coma increases the light scattering surface area but obscures the nucleus. The most accurate size estimates come from spacecraft missions and radar observations, but these are only available for a handful of comets. Other techniques (of varying levels of accuracy) include photometric observations of inactive nuclei at visible wavelengths, and infrared observations combined with thermal modelling of the coma and nucleus (e.g.[5], [6]).

Methods and Early Results: Using the database we have collated, we have conducted a range of statistical tests in order to assess any correlation between relative abundance of a species and nucleus size. We have assessed the Pearson correlation coefficient for each species, considering also the trends related to the different dynamical classes of comets (namely the Ecliptic Comets and the Nearly Isotropic Comets). Our initial results indicate the presence of correlations between the size and composition of comets. The strongest correlations occur for more volatile species such as CO & CH4, in that the nuclei of larger comets appear to be more abundant in these species (figure 1). This initial result seems to support the internal nucleus differentiation proposed by [1], whereby enhanced hypervolatile activity arises from sublimation of a concentrated shell formed by early radiogenic heating. We also find an intriguing correlation for the abundance of less-volatile CH3OH with size. In an upcoming publication we raise speculation for its presence as well.

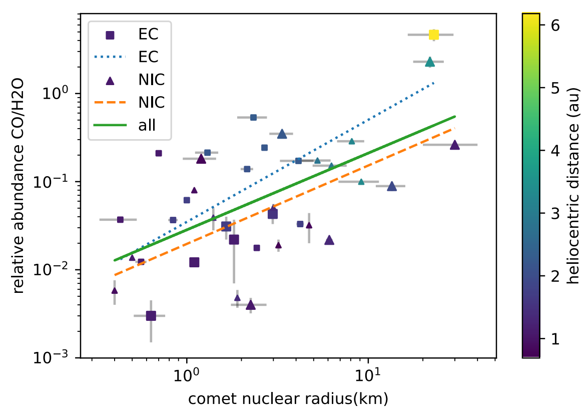

Figure 1: The relative fractional abundance of CO to H2O is plotted against the radius of the cometary nucleus in km. The trend is indicated by a linear fit to the data (Pearson correlation coefficient = 0.6).

Acknowledgments: J. Robinson and C. Opitom acknowledge the support of the Royal Society. U. Malamud, H. Perets and J. Blum are supported by the Niedersächsisches Vorab in the framework of the research cooperation between Israel and Lower Saxony under grant ZN 3630. NASA JPL SBDB and PDS data products (EAR-C-PHOT-5-RDR-LOWELL-COMET-DB-PR-V1.0 & urn:nasa:pds:compil-comet:nuc_properties::1.0) were used in this analysis.

References: [1] Malamud U. et al. (2022) *MNRAS*, 514, 3366 [2] Dello Russo N. et al. (2016) *Icarus*, 278, 301 [3] A'Hearn M. F. et al. (1995) *Icarus*, 118, 223 [4] Rubin, M. et al. (2019) *MNRAS* 489, 594 [5] Snodgrass C. et al. (2011) *MNRAS*, 414, 458 [6] Bauer J. M. et al. (2017) *AJ*, 154, 53