Extreme diversity in the composition of comets: the case of the "ultra-blue" comet C/2016 R2 (PanSTARRS)

N. Biver[1], D. Bockelée-Morvan[1], G. Paubert[2], J. Crovisier[1], E. Bertrand[3], H. Boussier[4], A. Cochran[5], A. McKay[6] et al.

[1] LESIA, Observatoire de Paris, PSL Research University, CNRS, Sorbonne Universités, Université Paris-Diderot, Sorbonne Paris Cité (5 place Jules Janssen, F-92195 Meudon, France , nicolas.biver@obspm.fr), [2] IRAM, Spain, [3]SAF / http://www.lesia.obspm.fr/comets, [4]IAU station K21 / SAF / http://www.lesia.obspm.fr/comets, [5]McDonald Observatory, University of Texas, USA, [6]NASA Goddard Space Flight Center / Universities Space Research Association

Comet 67P/Churyumov-Gerasimenko has been extensively studied and its coma composition monitored during the two years around its 2015 perihelion passage by the Rosetta mission. Nevertheless, 67P is only one sample of the comets of our Solar system, and to understand its origin and the formation of comets, we need a more comprehensive sample of comets. Comet C/2016 R2 (PanSTARRS) was investigated at visible (Cochran and McKay 2018, ApJ...) to radio wavelength in December 2017 – March 2018. This long period comet (Original period of 21600 years) passed perihelion on 9 may 2018 at 2.6 AU from the Sun. Its visual aspect resembles to that of comet C/1961 R1 (Humason), with a deep blue coma and tail dominated by the emission of CO^+ and N_2^+ at relatively large heliocentric distance. The N_2/CO abundance ratio could be inferred from visible spectroscopy, even with a small amateur telescope: it is 10 times higher than in comet 67P and 1000 times higher than the upper limit in comet Hale-Bopp. Observation with the IRAM-30m telescope on Jan. 23-24 further revealed a prodigious production of CO (5 ton per second) and strong depletion (by at least a factor 10) in other molecules (CH_3OH, HCN, H_2CO, H_2S) compared to all other comets observed at similar heliocentric distance. As an extreme example, the N_2/HCN ratio in C/2016 R2 is about **10000 times higher** than in 67P (at 2.8 AU from the Sun). In addition comet C/2016 R2 looks very dust poor in the visible: $Af\rho/Q_{CO}$ ~ 0.5 while it is around 40 for other comets such as Hale-Bopp, C/2006 W3 or C/2014 S2. Water was searched for via observation of the OH lines with the Nançay radio-telescope. We found **CO/H_2O > 10**, while in other comets the ratio is generally close to unity or less (<0.1 in 67P) at the same heliocentric distance.
This illustrates that very large differences in composition exists amongst comets and we are still far from having a comprehensive view of the diversity of comets.