EPSC Abstracts
Vol. 16, EPSC2022-494, 2022
https://doi.org/10.5194/epsc2022-494
Europlanet Science Congress 2022

Rosetta Zoo: finding changes on comet 67P

Jean-Baptiste Vincent[1], Sandor Kruk[2], Ellen Schallig[3], Michael Kueppers[4], Sébastien Besse[5], Claudia Mignone[6], Mark Bentley[4], David Heather[7], Samuel Birch[8], and Bruno Merín[4]
[1]DLR Institute for Planetary Research, Berlin, Germany (jean-baptiste.vincent@dlr.de)
[2]Max Planck Institute for Extraterrestrial Physics, Germany
[3]Zooniverse, Department of Physics, University of Oxford, England
[4]European Space Agency, ESAC, Spain
[5]Aurora Technology B.V. for European Space Agency, Spain
[6]INAF, Italy
[7]European Space Agency, ESTEC, The Netherlands
[8]Massachusetts Institute of Technology

Comets are generally considered to be relatively pristine objects, having spent most of their existence at large heliocentric distances where there is not enough energy to significantly transform these objects. Comets, therefore, offer a window into the early Solar System; their physical and chemical properties reflect the conditions in their formation environment [1].

Yet, most comets that have been visited by spacecraft are small-period comets that circle the Sun in 10 years or less, meaning that their surface is no longer as pristine as we would need to investigate their origins, having been modified by several processes such as impacts, sublimation, dust deposition and explosive outbursts over many orbits around the Sun. To learn about the early Solar System, we need to understand these evolution processes and recover the original conditions, and this requires building an exhaustive catalog of all types of changes that may have taken place, as well as the timeline of this evolution.

ESA's Rosetta mission at comet 67P provides the perfect data set for such a task [2]. Having monitored the comet's surface for two years, across perihelion, Rosetta witnessed a handful of large-scale changes such as cliff retreat, the deflation of smooth terrains and the transport of large size blocks. A whole lot more took place on smaller scales: a careful examination of selected high-resolution images has shown thousands of changes on a 1-10 meter scale, including the formation of small pits, impacts, rolling and bouncing boulders. The most significant changes have been presented in several publications [3-9], as well as the connection between morphological evolution and activity [10,11]. However, more than 5 years after the end of the mission, we still lack a complete description of changes at all scales. This is a challenging task, because most transformations are small (meter-size or less), which means the associated surface features occupy only a few pixels in the high-resolution images returned by Rosetta (OSIRIS NAC [12]).

Over the last years, we have started to systematically analyze images from different epochs, and developed specialized algorithms to assist in the detection of surface changes [13]. The results are promising, but only a subset of the data was analyzed, as the algorithm requires images to be co-aligned, a much time consuming step. In order to speed up the process and analyze the full surface, we have enlisted the help of thousands of comet enthusiasts through a citizen science project steered by ESA and Zooniverse. Volunteers are viewing pairs of OSIRIS images of the same region of the comet, taken before and after the perihelion passage, and we ask them to identify whether they see significant modifications between the two images, marking the areas that display changes in the two images with purposely-designed tools. Volunteers are also asked to label the type of change in the images.

This will produce maps of changes and active areas on the comet's surface, with labels for each type of change, from the visual inspection of many volunteers, enabling us to associate activity with surface modifications and thus develop new models linking the physics of comet activity to observed changes like lifted boulders and collapsed cliffs.

The database created from this citizen science project will also be used to verify the results given by the change detection algorithm, and will provide an excellent training set for potentially new machine learning efforts.

The project launched on the 5th of May 2022 and several thousands of classifications have already been performed by the first volunteers. We will monitor this collaborative work over the coming months and report on the first results at EPSC in September 2022.

Rosetta Zoo project: https://www.zooniverse.org/projects/ellenjj/rosetta-zoo/

References:

[1] Weissman et al, SSR (2020); [2] Taylor et al, MNRAS (2017); [3] Groussin et al, A&A (2015); [4] El Maarry et al, Science (2017); [5] Vincent et al, MNRAS (2017); [6] Birch et al, MNRAS (2017); [7] Pajola et al, NatAstro (2017); [8] Birch et al, GRL (2019); [9] Vincent et al, EPSC (2019); [10] El Maarry et al, ISSI/SSR (2020); [11] Vincent et al, ISSI/SSR (2020); [12] Keller et al, SSR (2007); [13] Vincent et al, EPSC (2021)