CORSAIR (COmet Rendezvous, Sample Acquisition, Investigation, and Return): A New Frontiers Mission Concept to Collect Samples from a Comet and Return them to Earth for Study

S. A. Sandford[1], N. L. Chabot[2], N. Dello Russo[2], J. C. Leary[2], E. L. Reynolds[2], H. A. Weaver[2], D. H. Wooden[1], and The CORSAIR Team. [1]NASA Ames Research Center, Space Sciences Division, Moffett Field, CA 94035 (Scott.A.Sandford@nasa.gov), [2]Johns Hopkins University Applied Physics Laboratory, 11100 Johns Hopkins Road, Laurel, MD 20723.

Introduction: Comets are time capsules that preserve materials from the dawn of the Solar System. The return of surface samples from a comet to Earth is one of the highest priorities listed for the New Frontiers Program in the last two Decadal Surveys. *CORSAIR* (COmet Rendezvous, Sample Acquisition, Investigation, and Return) is a mission concept that was submitted in May 2017 in response to NASA's New Frontiers 4 call. *CORSAIR's* proposed mission is straightforward: to return comet nucleus samples to Earth for detailed analysis. If approved, *CORSAIR* would rendezvous with comet 88P/Howell for at least 140 days to perform detailed physical and chemical characterization of its nucleus and coma and return to Earth with comet samples from both the nucleus of comet 88P/Howell and its coma. Any volatile ices that are collected are sublimated from the samples and chemically characterized before return. Comet 88P/Howell is ideal for *CORSAIR's* mission because it is a highly accessible, regularly observed, active Jupiter-family comet that offers both new discoveries and comparisons to previously visited comets.

Onboard Instrumentation: CORSAIR addresses the New Frontiers Program's focus on cometary organic material and the Decadal Survey goal of understanding the role of comets as ingredients for planets and life. *CORSAIR* uses a suite of onboard instruments to characterize the comet's nucleus and coma properties, providing sample context outlined in the New Frontiers objectives and addressing the Decadal Survey goal of deciphering the processes that shape comets. *CORSAIR's* flight instruments include:

- *CORSAIR* Dual Imaging System (CorDIS): simplified copy of the highly successful APL MESSENGER/MDIS instrument for near and wide angle imaging of the nucleus surface
- Coma Dust Sampler (CDS): JAXA-contributed coma dust flux monitoring and time-resolved (active) coma dust sampling system with an APL integrated (passive) coma dust sampler
- *CORSAIR* Altimetric Laser (CorAL): MDA copy of the OSIRIS-REx/OLA instrument for sample site topography and near-nucleus navigation
- *CORSAIR* THermal EMission Imaging System (C-THEMIS): ASU-provided, Mars Odyssey-heritage instrument for characterization of thermal inertia and mineralogical variability on the nucleus surface
- *CORSAIR* Mass Spectrometer (C-MaSt): University of Bern-contributed Rosetta/ROSINA heritage instrument for coma and sample volatile measurements
- Proximity Cameras (ProxCams): Malin Space Science Systems copies of the OSIRIS-REx TagCams for near-nucleus navigation and high spatial and temporal resolution imaging of the sampling events
- Radio Science (RS): onboard APL-heritage communications system enables comet nucleus mass determination

Returned Samples: CORSAIR delivers groundbreaking science through studies of the composition and organic inventory of comets using state-of-the-art analyses of the returned samples in terrestrial laboratories. In essence, *CORSAIR's* instrument payload includes all the world's analytical instrumentation. *CORSAIR* returns two nucleus samples and nine distinct collections of coma dust obtained during different rendezvous phases, enabling studies of heterogeneity within the comet, providing a missing link between surface and coma compositions, and surpassing New Frontiers objectives. *CORSAIR* uses a robust sample acquisition system developed during a decade of hardware development and testing that enables samples to be safely acquired without landing [1]. The system is designed to sample the nucleus over an extensive range of surface strengths and local topographies, down to depths of at least 10 cm, enabling the collection of primitive material stored under the comet surface.

Mission Phases: CORSAIR has six main phases: (1) Launch nominally occurs on 19 July 2024. (2) Cruise to the comet takes 7 years and includes two Earth gravity assists. (3) The 88P/Howell rendezvous (beginning May 2031) includes comet characterization, collection of two surface samples, and coma dust collection, and lasts up to 294 days. (4) The 4.3-year cruise back to Earth includes monitoring devolatilization of the nucleus samples and measuring the composition of the released volatiles. (5) Samples are returned to Earth and land at the Utah Test and Training Range. (6) During a two-year preliminary examination period, state-of-the-art analytical techniques are used to study the samples and support their curation as a lasting scientific legacy.

References: [1] Adams D. S., Leary J., Papadakis S., Apland C., Maddock R., et al. (2017) Comet Surface Sample Return: Sample Chain System Overview, IEEE Aerospace Conference, 4–11 March 2017, Big Sky, MT.