THE COMET NUCLEUS SAMPLE RETURN MISSION; Thomas J. Ahrens*, Seismological Laboratory 252-21, California Institute of Technology, Pasadena, CA 91125, and the Science Definition Team+

The return of a sample from a comet nucleus to the laboratories on Earth by means of a spacecraft has been recognized by both ESA and NASA of being of highest scientific merit.

Research on comet nucleus samples will carry the exploration of the solar system to its outer fringes. This mission may begin to provide scientific study of the presolar environment and possibly sample materials from interstellar and galactic regimes. The study of the most primitive material in the solar system probably will allow an experimental approach to chemical and physical processes which marked the beginning of the solar system.

ESA has committed itself in its approved long term plan, Horizon 2000 (ESA, 1984) to perform a Comet Nucleus Sample Return Mission (CNSR) within the next two decades as one of its four Cornerstone Missions. NASA has identified in its Core Program that CNSR as one of several augmented missions of highest priority (NASA, 1986).

The CNSR Mission will provide complementary and unique samples and ultimately data which build on previous cometary exploration carried out by earth-based and orbiting observatories, cometary flyby missions (such as Giotto, Vega, Suisei, and ICE) as well as the planned Comet Rendezvous and Asteroid Flyby Mission. The CNSR Mission also strongly complements and naturally follows the ongoing earth-based studies of other primitive objects including the undifferentiated meteorites, cosmic dust containing particles of cometary and asteroidal origin sampled on the earth and in the atmosphere, and in space.

Just as present laboratory techniques for meteoritic, lunar and cosmic dust studies utilize the most advanced analytical capabilities and have evolved with the availability of new technologies, future Earth-based sample analysis of a comet nucleus will undoubtedly employ state-of-the art methods.

Present research activities in studies of extraterrestrial materials coming from regions outside of our presently known solar system combined with advances in astrophysics, suggest that the study of a cometary sample in the laboratory will extend man's exploration of space beyond the solar system into the surrounding galaxy.

The Science Definition Team has been defining the science objective of a CNSR Mission. Initial recommendations (see also *Proc. ESA-CNSR Workshop,* ESA 1986) are:

1. Rendezvous with an active and fresh comet.
2. Characterize the surface of the nucleus into active and inactive regions, allow high resolution imaging of the sampling site and provide in-situ characterization of the sample site (temperature).
3. Acquire three classes of samples: one which preserves stratigraphy to a depth of at least 1 m, one containing the most volatile components, sealed to prevent any loss of such volatiles, and surface samples intended to provide a larger volume of possibly less volatile components for analysis.
4. Store the samples until return to Earth at temperatures at the ambient temperature at the sampling site, but in any case, below 160 K.
5. Distribute for study, cometary samples to scientists in established laboratories.

The core, surface and volatile samples may be compressed to occupy a smaller volume in the Earth return container. However, compression of the core and surface sample should be carried out in such a controlled manner that original stratigraphy is recoverable. All samples should be stored during return to Earth, if possible, at a

temperature below the ambient temperature at the sampling site. Both, ESA and NASA studies are under way to develop technological feasible CNSR mission profiles and carry out supporting engineering research. Present studies include different propulsion systems, such as chemical and solar electric propulsion, as well as, hybrid systems.

REFERENCES: **(1)** National Aeronautics and Space Administration, 1986, Planetary Exploration through year 2000, an Augmented Program, Part two of a Report by the Solar Systems Exploration Committee, Superintendent of Documents, Wash. D.C. **(2)** European Space Agency (1986) Comet Nucleus Sample Return, *Proc. ESA Workshop,* U. Kent, Canterbury UK, 15-17 July 1986, ESA SP-249, Paris, France. **(3)** European Space Agency (1984) Space Science, Horizon 2000, ESA SP 1070, Paris, France.

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* Chairman NASA, Science Definition Team

+ F. Begemann (Max Planck-Institut für Chemie, Mainz, FRG)
D. E. Brownlee (Dept. Astronomy, U. of Washington, Seattle, WA)
H. Campins (Planetary Science Institute, Tucson, AZ)
S. Chang (NASA/Ames Research Center, Moffett Field, CA)
A. Coradini (Instituto Astrofisia Spaziale, U. Roma, Italy)
P. Eberhardt (Physikalishes Instit, U. Bern, Switzerland)
M. Festou (Observatoire de Besancon, France)
E. Grün, (Chairman, ESA Science Definition Team, Max-Planck-Institut für Kernphysik, Heidelberg, FRG)
A. W. Harris (Jet Propulsion Laboratory, Pasadena, CA)
Y. Langevin (Université Paris-Sud, Orsay, France)
J. A. M. McDonnell (University of Kent, Canterbury, U. K.)
C. T. Pillinger (Dept. Earth Sciences, Open Univ., Milton Keynes, U. K.)
G. Schwehm (European Science and Technology Center, Noordwijk, Holland)
D. Stöffler (Inst. für Mineralogie, Westfalishe-Wilhelm U., Münster, FRG)
H. Wänke (Max Planck Institut für Chemie, Mainz, FRG)
G. J. Wasserburg (Div. Geol. Planet. Science, Calif. Inst. of Tech., Pasadena, CA)
R. M. West (European Southern Observatory, Munchen, FRG)
J. A. Wood (Smithsonian Astrophysical Observatory, Cambridge, MA)