At a meeting of the FACULTY OF ARTS AND SCIENCES on February 7, 2023, the following tribute to the life and service of the late Charles Wilson Burnham was spread upon the permanent records of the Faculty.

CHARLES WILSON BURNHAM

BORN: April 6, 1933
DIED: December 13, 2021

Charles Wilson Burnham was born in Detroit, Michigan, on April 6, 1933, to Charles Hubbard Burnham and Anne Wilson Burnham. His early years were spent in Winchester, Massachusetts. In 1950, he enrolled at MIT, following in the footsteps of his father and grandfather before him. Although his major was engineering and business, he developed an interest in geology and took many courses in that subject. After graduation in June 1954, he started a master's program in geology, spending an additional year at MIT. His studies, however, were interrupted by military service: he spent 1955–1957 on active duty in the U.S. Air Force, where his duties were mainly in meteorology and ice physics. Returning to MIT, Charlie entered a Ph.D. program in the field of mineralogy and crystallography, studying under the pioneering crystallographer Martin Buerger. He received his Ph.D. in 1961, with a dissertation entitled "The Structures and Crystal Chemistry of the Aluminum Silicate Minerals."

After receiving his diploma, Charlie assumed a postdoctoral fellowship at the Geophysical Laboratory of the Carnegie Institute of Washington (1961–1963). Later, he was appointed staff scientist, a position he retained until 1966. The period 1961–1966 was a watershed in the history of mineralogy and crystallography, when the development of a new generation of automated X-ray diffractometers was accompanied by the availability of powerful mainframe computers such as the IBM 7094. One of Charlie's first accomplishments at Carnegie was to install a modern single-crystal X-ray diffractometer to carry out state-of-the-art crystal structure analyses. Charlie was an early adopter and leader in developing computer software to handle data streams from automated diffractometers. As noted in the introduction to the *Carnegie Institution Year Book* of 1963, "Modern scintillation and proportional counting techniques, and high-speed digital computers, are now the crystal structure analyst's most powerful tools."

Building on his doctoral research regarding the structures of the aluminum silicate minerals, Charlie pursued structural studies of mullite, another aluminum silicate generally used in its synthetic form in the ceramics industry. Mullite has a unique structure on account of its

nonstoichiometric composition involving oxygen vacancies that are charge balanced by aluminum substitution for silicon. Later, in collaboration with Donald H. Lindsley, Charlie investigated the structure of the ferrosilite ($FeSiO_3$) polymorphs that Lindsley had synthesized. This proved to be a new pyroxenoid-type structure with a single silicate tetrahedral chain containing a nine-tetrahedra repeat group. At the time, only pyroxenoids with three, five, and seven repeat chains were known. Consequent work with Lindsley in the binary ferrosilite-wollastonite ($FeSiO_3$-$CaSiO_3$) system led to synthesis and structural analysis of a seven-repeat pyroxenoid equivalent to the mineral pyroxferroite, which subsequently was found in lunar samples returned from Apollo 11.

Although the environment for pure research at the Geophysical Lab remained unparalleled, the opportunity to interact with students, both undergraduate and graduate, led Charlie to accept an appointment as Associate Professor of Mineralogy in the Department of Geological Sciences at Harvard in 1966. As with his arrival at the Geophysical Lab in 1961, Charlie found that equipment for crystallographic research was limited and old. Supported by funding from both Harvard and the National Science Foundation, he acquired and installed a computer-controlled, electronic, counter-equipped, automated single-crystal X-ray diffractometer. This upgraded lab equipment was used extensively by a large number of graduate and postgraduate students and postdocs in the ensuing years. Charlie was promoted to Professor of Mineralogy in 1969, remaining in that position until his retirement in 1996.

Working with a number of students and postdocs during the 1970s and 1980s, Charlie's group pioneered structural studies at high temperatures and high pressures using a miniature diamond cell. These studies led to successful predictions of silicate structures at high temperatures and pressures typical of regional metamorphism, igneous rock formation, and conditions deep within the Earth. A collaboration with Professor James B. Thompson, Jr., and the graduate student David Veblen led to the discovery and description of an entirely new class of triple-chain silicate minerals, including chesterite and jimthompsonite.

In the 1980s, Charlie recognized that it was possible to build on the wealth of structural studies reported in the two previous decades that had established accurate interatomic distances for atoms in a variety of structures. These known interatomic distances could, in turn, be used to develop ionic pair potentials. Mathematical techniques such as distance-least-squares (DLS) could then be used to simulate complex mineral structures. In addition, the development by W. R. Busing at the Oak Ridge National Laboratory of a general structure energy minimization program allowed even more extensive simulations. At the same time, Professor Roy G. Gordon and Harvard coworkers developed the modified electron gas (MEG) theory for ionic structures, providing another way by which ionic pair potentials could be established. These developments led to a golden age of simulations of ionic crystal structures.

A gifted and renowned teacher, Charlie worked with a number of graduate students and

postdocs who went on to successful careers of their own. Charlie was especially proud that some of these young scientists earned recognition, including the prestigious Mineralogical Society of America (MSA) Award for young scientists. Charlie himself served as President of MSA in 1989–1990, as did seven of his students thereafter. In addition to his teaching of mineralogy, he offered a popular freshman seminar on glaciology and glacial geology and served the Department of Geological Sciences as Head Tutor for more than ten years.

Outside of his professional activities, Charlie was active in the local environmental community, working on major issues in backcountry management. He served as President of the Appalachian Mountain Club in 1979–1980 and participated in negotiations for land acquisition and the routing of the Interstate 93 highway through the narrow pass of Franconia Notch in New Hampshire. An avid skier, Charlie also promoted youth ski racing nationally and served as a course official in two separate Olympic competitions.

Charlie passed away on December 13, 2021. He is survived by his wife, Mary Sue; sons Jeffrey and David; and six grandchildren.

Respectfully submitted,

Mark Van Baalen
Charles H. Langmuir
Michael B. McElroy, Chair