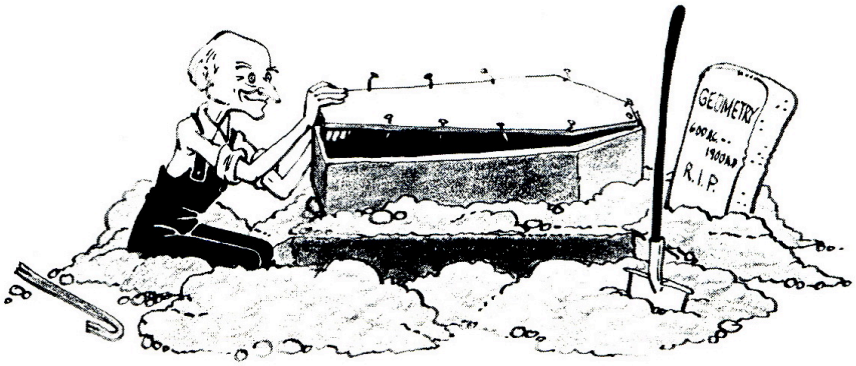
A COXETER COLLOQUIUM

On Friday, November 3, 2006
At Princeton



"Coxeter exhuming Geometry" by David Logothetti

PROGRAMME

For further information:
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DEDICATION

10:30-11:30am, Quark Park
(see below attached for directions)

A dedication ceremony for John Conway's 4-dimensional dodecahedron sculpture by Marc Pelletier will take place at Quark Park.

The sculpture is a copy of one that was presented by an anonymous donor to the Fields Mathematical Institute in Toronto to honor the 95th birthday of H.S.M. (Donald) Coxeter in February 2002. The same donor presented this sculpture to the Princeton University Mathematics Department in honor of Professor John H. Conway.

The dodecahedral sculpture is a 3-dimensional shadow, or "projection," of the analogous 4-dimensional figure – called the "polydodecahedron" or the "120-cell" – whose 120 cells (or three-dimensional faces) are regular dodecahedra. The surface of this 5-foot diameter ball resembles a soccer ball, with 30 hexagons (split into four pentagons arising from 30 dodecahedrons which are projected onto 2-dimensional figures) and 12 pentagons, which are the faces of 12 dodecahedrons in the outer shell of the figure.

"Although the polydodecahedron is a gemlike object living in a space that is inaccessible to us," says Conway, "we can gain some appreciation of its beauty from Marc's sculpture."

Quark Park is an outdoor exhibition of works by more than a dozen scientists teamed with artists – Freeman Dyson contributed an installation in collaboration with US Congressman Rush Holt and architect Alan Kehrt, and Princeton University President Shirley Tilghman collaborated with sculptor Nancy Cohen.

Dyson contributed a sundial structure to Quark Park. Accompanying illustrations explain the geometry behind a sundial, and give a deeper understanding of the physics of the sun. Dyson describes his installation in saying: "This installation reflects the understanding that the basis of human time telling is the sun...A bench is provided for this observation and observers are encouraged to follow the sun's shadow as it tracks across the wall to the west of the path; chalk is provided to mark your own observations. The installation is designed as a garden to remind us that our sun supports all of the life on earth. The shadow indicates the time of day in Eastern Standard Time, ignoring our artificial manipulations of time each summer."

Visit the Quark Park website for further description of the installations:
http://www.princetonoccasion.org/quarkpark/teambios.html

COLLOQUIUM

1-5pm, Main Lecture Room, Peyton Hall, Princeton
(see below and attached for directions)

The Colloquium will be comprised of two sessions; each talk will be15 minutes.

SESSION ONE – 1-2:45pm

J.R. GOTT III – Welcome

SIOBHAN ROBERTS on "Unfashionable Pursuits," an excerpt form *King of Infinite Space*

FREEMAN DYSON on "How Polyhedra Fit Into Each Other"
"This is the problem that first got me interested in polyhedra long ago, when I first encountered Coxeter's writings," says Dyson, a physicist and polymath at the Institute for Advanced Study. Dyson was introduced to Coxeter by Leopold Infeld in the 1940s. The two polyhedra enthusiasts hit it off and maintained a leisurely correspondence about, of course, polyhedra, which developed into a lifelong friendship from afar– Dyson counted Coxeter as "one of my favorite people."

MICHAEL LONGUET-HIGGINS on "Snub Polyhedra and Organic Growth"
Michael Longuet-Higgins, a geophysicist and geometer at UCSD, and a Fellow of Trinity College, Cambridge, met Coxeter via Freeman Dyson – Dyson put the two men in touch when he learned they were both trying to enumerate the class of uniform polyhedra. Longuet-Higgins and Coxeter, together with J.C.P. Miller, published what they believed to be a complete enumeration of uniform polyhedra in 1954 (it was proven to be complete, by a computer, in 1975). Longuet-Higgins will describe a new application of polyhedral theory to the growth of the outer sheath of viruses. These structures are often modular with cheiral (unselfreflexible) symmetry. The growth can be simulated by a time-dependent process applied to equal-sized circles on a sphere. First the circles are jostled by random perturbations, then their radius is enlarged, then they are jostled, and so on. The limiting arrangement of the circles is one with the maximum coverage of the surface of the sphere and is related to a snub polyhedron. Coxeter's interest in "Vegetable Staticks" suggests that he would have liked this "yin-yang" method."

GEORGE HART on "The Geometric Aesthetic"
Hart is research professor in the department of computer science at Stony Brook University, New York, and a sculptor who makes impressionistic polyhedral sculptures – sometimes of plastic knives and forks – that are so complex they require a "barn-raising" to erect. He will speak about Coxeter's influence on his art. "My sculpture would not exist if Coxeter did not exist," says Hart. "Coxeter's book *Regular Polytopes* opened my eyes to what geometry could be." Hart is also the author of the web-based *Encyclopedia of Polyhedra*, which can be found at http://www.georgehart.com

DORIS SCHATTSCHNEIDER on "Coxeter and the Artists"
Schattschneider, professor emerita of mathematics at Moravian College, in Bethlehem, PA, will speak about Coxeter's collaborations with a number of artists, a subject on which she has investigated and written extensively. On this occasion she will include the British sculptor John Robinson, the painter and amateur geometer George Odom, based in Poughkeepsie, NY, and the Dutch artist M.C. Escher. Coxeter's geometric figures of the hyperbolic plane directly inspired Escher's *Circle Limit III* prints.

MARJORIE SENECHAL on "Coxeter, the verb"
Coxeter's name was already a proper noun – for example, Coxeter group and Coxeter diagram – but M.C. Escher transformed the geometer into a verb: working on his *Circle Limit* prints, Escher was known to say, "I'm Coxetering today!" "Escher spoke jokingly of "coxetering", but it's no longer a joke," says Marjorie Senechal. "We all coxeter now." Senechal, the Louise Wolff Kahn Professor in Mathematics and History of Science and Technology at Smith College in Northampton, MA, and co-editor of *The Mathematical Intelligencer*, will explain what she means by this and propose a suitable entry – definition, usage, etymology – for the Oxford English Dictionary.

BREAK 2:45-3:15pm
Refreshments in Lobby

SESSION TWO: 3:15-5:30pm

NEIL SLOANE on "The Music of Quadratic Forms"

Sloane, an AT&T Fellow, Member National Academy of Engineering, etc., is the creator of the On-Line Encyclopedia of Integer Sequences. He has recently been experimenting with different ways to study number sequences, both graphically and musically. He will show some remarkable pictures and play computer-simulated piano sequences that are related to Coxeter's work on quadratic forms. "There are thousands of notes and they go by VERY fast," he says. Sloane will also display a sequence, discovered by Bernardo Recamán Santos, that is so difficult to decipher that it has been described as "How to Recamán's Life."

JOHN CONWAY on "The Four Dimensional Polytopes"

Conway, the discoverer of surreal numbers and the John Von Neumann Professor of Mathematics at Princeton, considers himself an honorary student of Coxeter's. And he is considered by many to be Coxeter's spiritual successor as a geometer. During his university days at Cambridge, Conway was known to walk around wearing a helmet, a homemade contraption with army surplus periscopes screwed onto it which nearly allowed him to see in four spatial dimensions. He will speak on 4-dimensional polytopes. And he will tell the story of how Coxeter once tried to kill him with a problem pertaining to the rotational polyhedral groups and Coxeter groups, which resulted in a theorem that Conway now calls, "The Murder Weapon."

TONY ROBBIN on "Coxeter, Hyper-Tessellations, and Quasicrystals"

Robbin, based in New York, is pioneer in the computer visualization of 4-dimensional geometry. He has created large-scale quasicrystal sculptures in Denmark and the United States. Robbin is the author of *Engineering a New Architecture* and *Shadows of Reality* (both YUP). Following in the path of many geometers and artists the world over, Robbin wrote to Coxeter to ask a question. "In 1982, I had a question about tessellations of hypercubes," said Robbin, "and I still have the letter he wrote back. Coxeter made it all very clear to me." The resulting insights generated the mural size painting Fourfield, and the computer program HYPERS, which he will show, that displays nine tessellated hypercubes rotating in four-dimensional space.

MARC PELLETIER on "Coxeter's Model Maker, Paul Donchian"

Pelletier, a sculptor from Boulder, Colorado, who built the Conway and Coxeter 120-cells, and five others, will speak about Paul Donchian, whose

models appeared in a number of Coxeter's books, including Regular Polytopes. Donchian was a rug salesman by trade, but his obsession with hyperspace and making models to depict it, consumed so much of his time that his rug business struggled financially. Donchian exhibited his hyperspace models at Chicago's World Fair in 1934, where Coxeter first encountered him. One newspaper headline read: "Paul S. Donchian Opens Door To a Fairyland of Pure Science, His Wire and Cardboard Models Explain Highest Mathematics," while another noted: "Einstein Was Barred From Exhibit Lest Crowds Crush Both Him and Models."

ROE GOODMAN on "Alice Through Looking-Glass after Looking-Glass – The Mathematics of Kaleidoscopes"

Goodman, a professor of mathematics at Rutgers University, in New Brunswick, New Jersey, will speak about Coxeter's very visual approach to geometry, using kaleidoscopes to investigate the symmetries of solids and shapes. As a student at Cambridge, Coxeter carried with him at all times his portable kaleidoscopes, protected in felt pouches sewn by his mother. Goodman constructed a similar set of kaleidoscopes to help his students understand reflection groups in the theory of Lie algebras. He will display these kaleidoscopes and explore their mechanics by drawing an analogy to Alice's adventures in Wonderland, imagining Alice's trip through a peculiar cone-shaped arrangement of three looking glasses. "Alice wonders how many different ways the mirrors could be arranged so that she could have other trips through the looking glasses and still return the same day for tea," Goodman wrote in a paper on the subject. "Alice's problem was solved (for all dimensions) by H.S.M. Coxeter, who classified all possible systems of *n* mirrors in *n*-dimensional Euclidean space whose reflections generate a finite group of orthogonal matrices."

J.R. GOTT III on "Regular Skew Polyhedra and the Sponge-Like Topology of the Large Scale Structure in the Universe."

Gott, a professor of astrophysics at Princeton, first became acquainted with the regular skew polyhedra almost forty years after Coxeter discovered these new geometric solids as a teenager with his friend John Petrie. Gott was a teenager himself when he rediscovered the same figures. "The first one I found was hexagons-four-around-a-point," he said. "I noticed four hexagons could join in a saddle-shaped surface and this could be continued to make a repeating sponge-like structure." Gott will discuss this Coxeterian intersection of

discoveries and describe how he has since applied his knowledge of the skew polyhedra to his work in astrophysics.

SIOBHAN ROBERTS on "Jeff Weeks's Dodecahedral Universe," a computer-animated excerpt from *King of Infinite Space*, with 3D glasses.

RECEPTION

6-7:30pm, Hosted by Dr. Peter Goddard, Director, IAS
At Olden Farm (see below and attached for directions)

DIRECTIONS

QUARK PARK
* Quark Park is located at Paul Robeson Pl. between Chambers and Witherspoon Streets in the city of Princeton
*see directions on the Quark Park website at:
http://www.princetonoccasion.org/quarkpark/

PEYTON HALL
*see attached map to locate Peyton Hall on the Princeton Campus – Peyton is H-3.5 on the grid
*due to construction access to Peyton requires a detour, details at:
http://www.princetonastronomy.org/peytondirections.html
*for detailed plane, train, and car directions to Princeton, see:
http://www.astro.princeton.edu/travel_directions.htm

OLDEN FARM
*see attached map to locate Olden Farm with respect to Peyton Hall; Olden Farm is #15 at the top center of the map
* Olden Farm is at 97 Olden Lane. It is the house of the Director of the IAS, Dr. Peter Goddard. It is the original farmhouse of the farm on which the Institute was built and is about 2 miles from Peyton Hall by car and about 1.5 miles by foot (because you can cut across the University campus). A taxi is about $15.