MG12

MARCEL GROSSMANN AWARDS

PARIS 2009

ICRA and ICRANet

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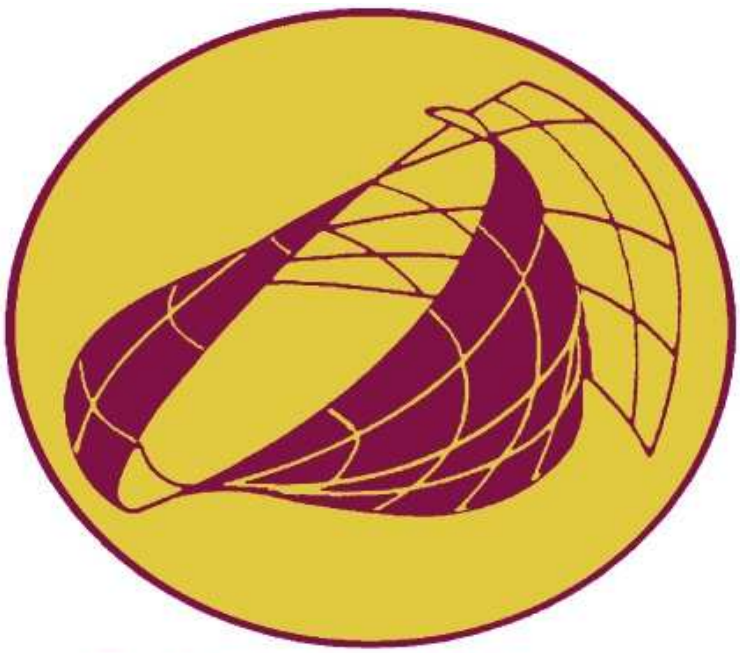
and

TEST



ICRANet

The Institut des Hautes Études Scientifiques is a French institute supporting advanced research in mathematics and theoretical physics. It was created in 1958 by Léon Motchane, an industrialist with a passion for mathematics, with the support of Robert Oppenheimer. It has a small number of permanent professors, appointed for life, and invites about 200 visitors a year for varying terms averaging three months. Over the past decade, 2370 scientists from 60 countries have come to carry out their work at IHÉS. Research is not contracted or directed: it is left to each individual researcher to pursue their own goals. Jean-Pierre Bourguignon is the present Director of IHÉS.

12th Marcel Grossmann Meeting

July 2009, Paris

Institutional Award

Institut des Hautes Etudes Scientifique (IHES)
for its outstanding contributions to mathematics and theoretical physics, and notably for having renewed basic geometrical concepts, and having developed new mathematical and physical aspects of spacetime.
- presented to Prof. Jean-Pierre Bourguignon

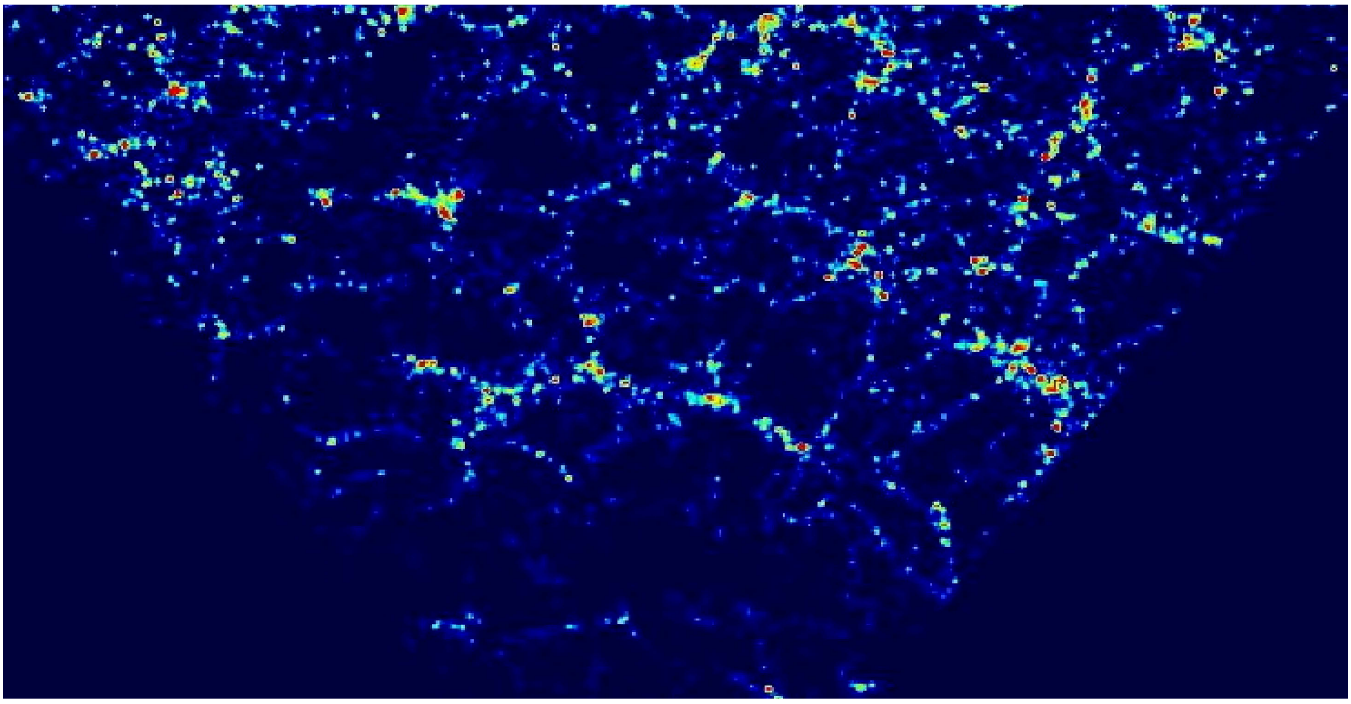
Individual Awards

Jaan Einasto
for pioneering contributions in the discovery of dark matter and cosmic web and fostering research in the historical Tartu Observatory.

Christine Jones
for her fundamental contributions to the X-ray studies of galaxies and clusters tracing their formation and evolution and for her role in collaborations using clusters to study dark matter and in analyzing the effects of outbursts from supermassive black holes on the intracluster gas.

Michael Kramer
for his fundamental contributions to pulsar astrophysics, and notably for having first confirmed the existence of spin-orbit precession in binary pulsars.

Each recipient is presented with a silver casting of the TEST sculpture by the artist A. Pierelli. The original casting was presented to His Holiness Pope John Paul II on the first occasion of the Marcel Grossmann Awards.



Picture of Jaan Einasto, Professor at Tartu Observatory. Tartu Observatory is on the UNESCO WHL as the part on Struve Geodetic Arc: a chain of survey triangulation stretching from Hammerfest in Norway to the Black Sea, for over 2,820 km. These are points of a survey, carried out between 1816 and 1855 by Friedrich Georg Wilhelm Struve. A 1000 Megaparsec view of our Universe developed at ICRANet Pescara in May 2009 by Jaan Einasto, illustrating that galaxies must form in filaments (Einasto, Saar, Joeveer 1977, 1980).

11th Marcel Grossmann Meeting
July 2006, Berlin

Institutional Award

FREIE UNIVERSITÄT BERLIN
for the successful endeavour of re-establishing — in the spirit of the Humboldt tradition — freedom of thinking and teaching within a democratic society in a rapidly evolving cosmos —presented to Dr. Dieter Lenzen, President of FUB

Individual Awards

ROY KERR
for his fundamental contribution to Einstein's theory of general relativity: "The gravitational field of a spinning mass as an example of algebraically special metrics."

GEORGE COYNE
for his committed support for the international development of relativistic astrophysics and for his dedication to fostering an enlightened relationship between science and religion.

JOACHIM TRUMPER
for his outstanding scientific contributions to the physics of compact astrophysical objects and for leading the highly successful ROSAT mission which discovered more then 200,000 galactic and extragalactic X-ray sources: a major step in the observational capabilities of X-ray astronomy and in the knowledge of our universe.

10th Marcel Grossmann Meeting
July 2003, Rio di Janiero

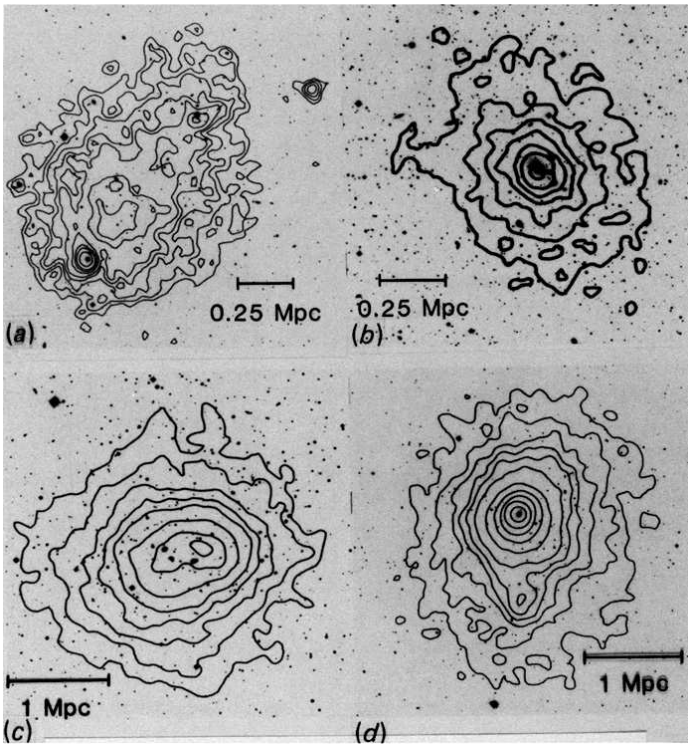
Institutional Award

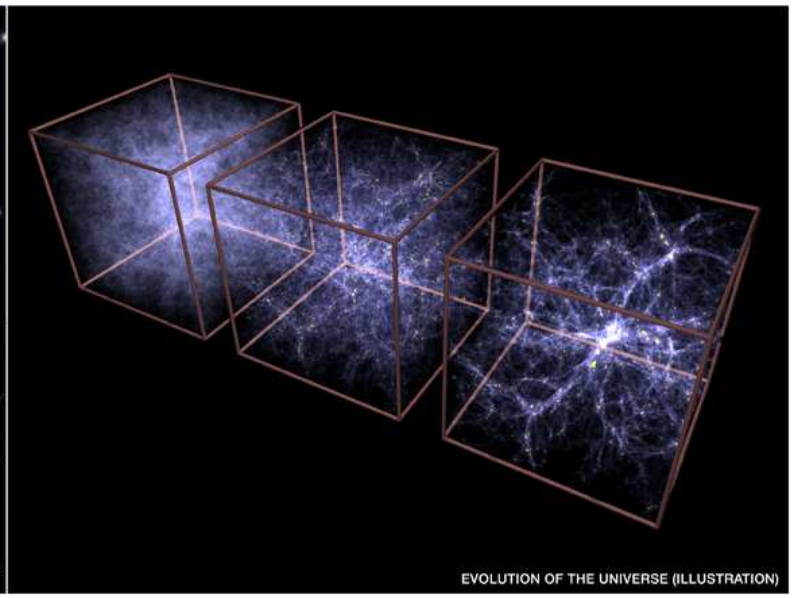
CBPF (Brazilian Center for Research in Physics)
for its role as a teaching and research institution and as a place originating fundamental physics ideas in the exploration of the universe.
—presented to its founders Cesar Lattes, Jos´e Leite Lopez and Jayme Tiomno

Individual Awards

YVONNE CHOQUET-BRUHAT AND JAMES W. YORK, JR.
for separate as well as joint work in establishing the mathematical framework for proving the existence and uniqueness of solutions to Einstein's gravitational field equations.

YUVAL NE'EMAN
for his contributions to science, epistimology, mathematics and physics from subnuclear to space sciences.





Imaging X-ray telescopes have allowed a tremendous leap in our understanding of the distribution of hot gas and dark matter in clusters of galaxies, the most massive collapsed systems in theUniverse. Although small rocket-borne X-ray mirrors had observed the X-ray emission from the Coma, Perseus and M87/Virgo clusters, only with the launch of the Einstein X-ray observatory, were large numbers of clusters imaged, showing that these very massive structures continue to evolve (figure on right shows isointensity contours of the X-ray emission from four clusters observed with Einstein). Today the high angular resolution of the Chandra X-ray Observatory shows the structure of clusters in great detail (bottom left shows X-ray emission (purple) on an optical image). The study of X-ray imaging observations of clusters was pioneered by Christine Jones (top left) and her husband and colleague William R. Forman.

9th Marcel Grossmann Meeting
July 2000, Rome

Institutional Award

SOLVAY INSTITUTES
for identifying and recording in discussions by the protagonists the crucial developments of physics and astrophysics in the twentieth century.
—presented to Jacques Solvay

Individual Awards

CECILLE AND BRYCE DEWITT
for promoting General Relativity and Mathematics research and inventing the "summer school" concept.

RICCARDO GIACCONI
for opening, five successive times, new highways for exploring the Universe.

ROGER PENROSE
for extending the mathematical and geometrical foundations of General Relativity.

8th Marcel Grossmann Meeting
June 1997, Jerusalem

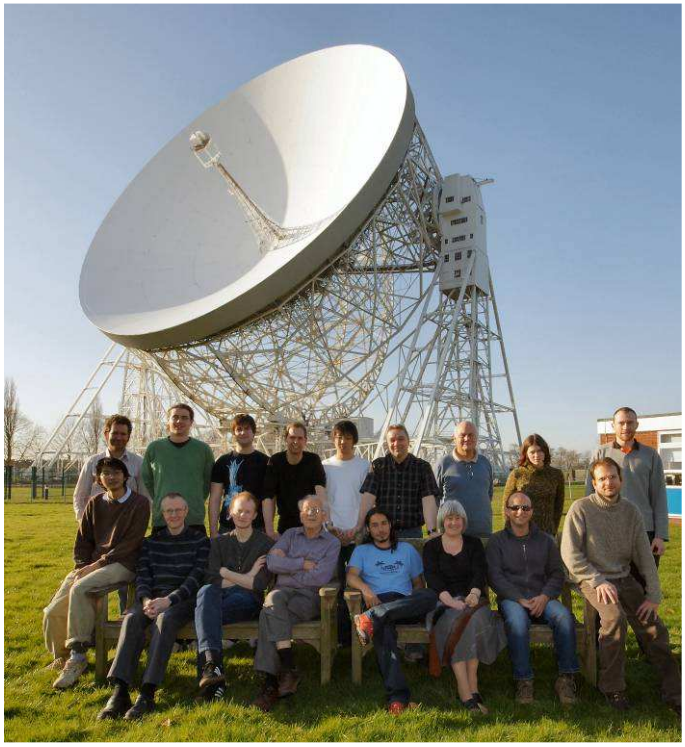
Institutional Award

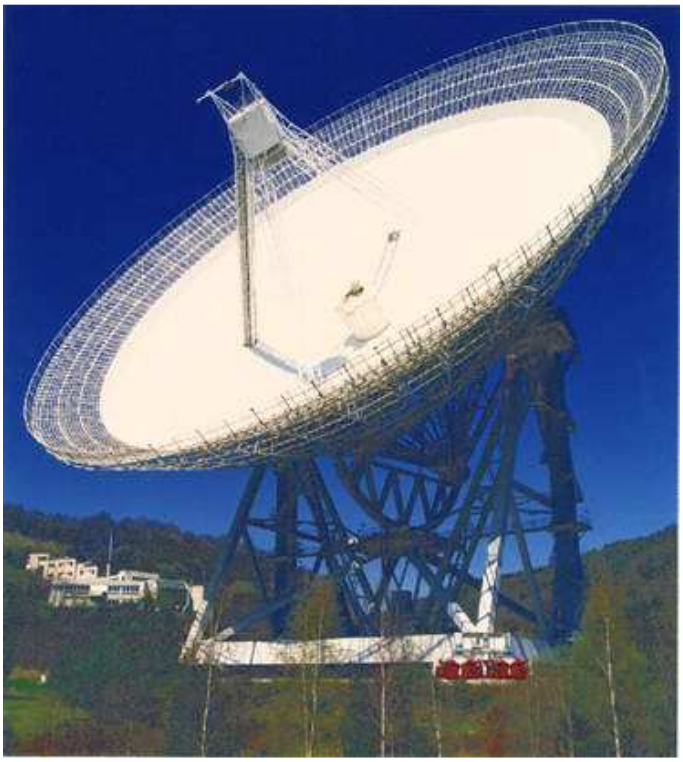
HEBREW UNIVERSITY
for its role as a cradle of Science and Humanities and for hosting the manuscripts of Albert Einstein.
— presented to M. Magidor, President of the Hebrew University of Jerusalem

Individual Awards

TULLIO REGGE
for his contributions to the interface between mathematics and physics leading to new fields of research of paramount importance in relativisic astrophysics and particle physics.

FRANCIS EVERITT
for leading the development of extremely precise space experiments utilizing superconducting technology to test General Relativity and the Equivalence Principle.





Michael Kramer (left) obtained his PhD in 1995 with a study of pulsars and neutron stars at the Max-Planck-Institut für Radioastronomie (MPIfR). After time in Berkeley, he became a lecturer for physics and astronomy at the University of Manchester in 1999, where he used the Lovell telescope at the University's Jodrell Bank Observatory for his research. From 2005 he was head of the world's largest pulsar group at Jodrell Bank (middle picture) and since 2006 he is full professor for astrophysics at the University. In March 2009 he also became director at the MPIfR in Bonn, holding a joint position with Manchester. He is now responsible for the Effelsberg 100-m radio telescope (bottom picture) which he also used to detect the effects of geodetic precession in the Hulse-Taylor Pulsar in 1998.

7th Marcel Grossmann Meeting
June 1994, Stanford, USA

Institutional Award

SPACE TELESCOPE SCIENCE INSTITUTE
for its critical role in the direction and operation of the Hubble Space Telescope, a truly unique international laboratory for the investigation and testing of general relativity in the context of modern astrophysics and cosmology.
— presented to Peter Stockman

Individual Awards

SUBRAHMANYAN CHANDRASEKHAR
for his contributions to the analysis of gravitational phenomena from Newton to Einstein and especially for leading the way to relativistic astrophysics with the concept of critical mass for gravitational collapse.

JIM WILSON
for having built on his experience in nuclear physics, thermonuclear reactions, and extensive numerical simulation to create a new testing ground for the novel concepts of relativistic astrophysics.

6th Marcel Grossmann Meeting
June 1991, Kyoto, Japan

Institutional Award

RITP
for keeping alive first in Hiroshima and them in Kyoto research in relativity, cosmology, and relativistic field theory and the development of a school of international acclaim.
— presented to Professor K. Tomita

Individual Awards

MINORU ODA
for participating in the pioneering work of the early sixties in X-ray astronomy and for his subsequent molding of an agile and diversified Japanese scientific space program investigating the deepest aspects of relativistic astrophysics.

STEPHEN HAWKING
for his contributions to the understanding of spacetime singularities and of the large scale structure of the Universe and of its quantum origins.

5th Marcel Grossmann Meeting
August 1988, Perth, Australia

Institutional Award

THE UNIVERSITY OF WESTERN AUSTRALIA
for its contributions to relativistic astrophysics.
— presented to the Vice Chancellor, Professor Robert Smith

Individual Awards

SATIO HAYAKAWA
for his contributions to research in gamma, X-ray and infrared radiation as well as cosmic rays.

JOHN ARCHIBALD WHEELER
for his contributions to geometrodynamics and Einstein's visions.

4th Marcel Grossmann Meeting
July 1985, Rome, Italy

Institutional Award

THE VATICAN OBSERVATORY
for its contributions to the origin and development of astrophysics.
— presented to His Holiness Pope John Paul II

Individual Awards

WILLIAM FAIRBANK
for his work in gravitation and low temperature physics.

ABDUS SALAM
for his work in unifying fundamental interactions.

TEST: **T**raction of **E**vents in **S**pace-**T**ime

Anna Imponente
National Gallery of Modern Art, Rome

The TEST sculpture provides an innovative example of interaction between science and art, not abstractly interpreted as a result of a subsequent critical analysis but indeed an active and creative collaboration between an astrophysicist and a sculptor.

In order to comprehend the meaning of collaboration between scientists and artists and to retrace its historical origin, we must go back to the Renaissance. There we find the so-called *Weltanschaung* and the idea of unitary art as a continuous and inseparable process of recognition of the structure of reality. This underlies the experience of Leonardo Da Vinci's talent, expressed in his drawings, of not separating scientific enquiry from artistic research.

In the seventeenth century, the "climb to the stars" of the stage machinery in baroque scenography, nourished by imagination, had loosened this link. It had coincided, on the one hand, with experimental Galilean sciences pursuing exact research towards a rational comprehension of the universe, and on the other hand, with the flourishing of the poetics of subjectivity, taste and feeling, the *beaux arts*, and a stratification of painting into specialistic genres.

In the nineteenth century, however, a new reversal of this trend can be observed: the scientific achievements of H.L. Helmholtz in the field of optics and of E. Chevreul in that of chemistry helps *pointillistes* painters in the separation of color. Furthermore, at the beginning of the twentieth century (1907) the Cubist revolution, which changes the concepts of space and time towards a simultaneity of vision, is synchronized with Einstein's theory of special relativity (1905).

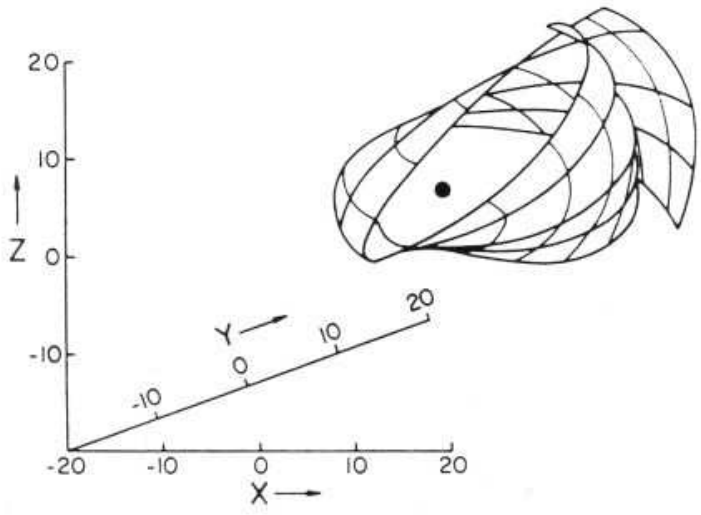
$$\dot{r} = \rho^{-2}\{[E(r^2+a^2) - a\Phi]^2 - \Delta(\mu^2 r^2 + K)\}^{1/2}$$

$$\dot{\theta} = \rho^{-2}\{K - (\Phi - aE)^2 - \cos^2\theta[a^2(\mu^2 - E^2) + \Phi^2 \sin^{-2}\theta]\}^{1/2}$$

$$\dot{t} = -a\rho^{-2}(aE\sin^2\theta - \Phi) + \rho^{-2}(r^2+a^2)\Delta^{-1}P$$

$$\dot{\phi} = -\rho^{-2}(aE - \Phi\sin^{-2}\theta) + a\rho^{-2}\Delta^{-1}P$$

$$E = .968\ ,\ \Phi = 2\ ,\ Q = 10\ ,\ a = e = 1/\sqrt{2}$$



Equations for a family of geodesics in a Kerr black hole and their graphical representation (*M. Johnston and R. Ruffini, 1974*).

The relationship between Remo Ruffini and Attilio Pierelli was not one of director/implementer nor could it exactly be defined as a four-handed performance. It has instead been a line of work suggested to the artist by a graphic design which had already been scientifically tested and computerized by M. Johnston and Ruffini at Princeton University in 1974.

This scientific investigation concerned the calculation of the geometric motion of five particles moving in space-time according to the application of a solution of Einstein's equations; the *in vitro* materialization and the visible replica of the discovery of a phenomenon existing in our own galaxy, namely the *black hole*, consisting of a stellar mass which is sucked into itself by gravitational collapse under the effect of its own self-gravity.

The encounter between Ruffini and Pierelli was not just a coincidence. On the one hand, there is the scientist, who in investigating astrophysical laws has always matched the exactness of results with the acknowledgement of a natural elegance of formulas, approaching an aesthetic outline of the detailed calculations. On the other hand, there is the sculptor, who appeases his eagerness for geometry by the contemplation of intricate reflecting symmetries and by perspective-illusive visions based on proportionate sizes, with the intention of proving the poetry of pure science before it becomes a technological adventure. In the theoretical formulation of his research on space, Pierelli has surveyed the history of mathematical thought and non-Euclidean geometries, deriving his hyperspatial shapes from the investigations of Gerolamo Saccheri, a Jesuit philosopher and mathematician of the seventeenth century.

The intuition of the aesthetic potential of this new form derived from the integration of Einstein's equations and describing the geodesics or trajectories of bodies around a black hole is compared by Ruffini to the "Greeks' discovery of π and the circle, which led to Hellenic architecture and the column" (interview with R. Ruffini by F. Bellonzi, Rome, 1985). Initially in 1981 the structural novelty of this form was understood by the architect Maurizio Sacripanti when he considered it as a space one can enter with one's own body and perceive directly with one's senses (M. Sacripanti in *Catalogo Roma*, Palazzo delle Esposizioni, 1981).

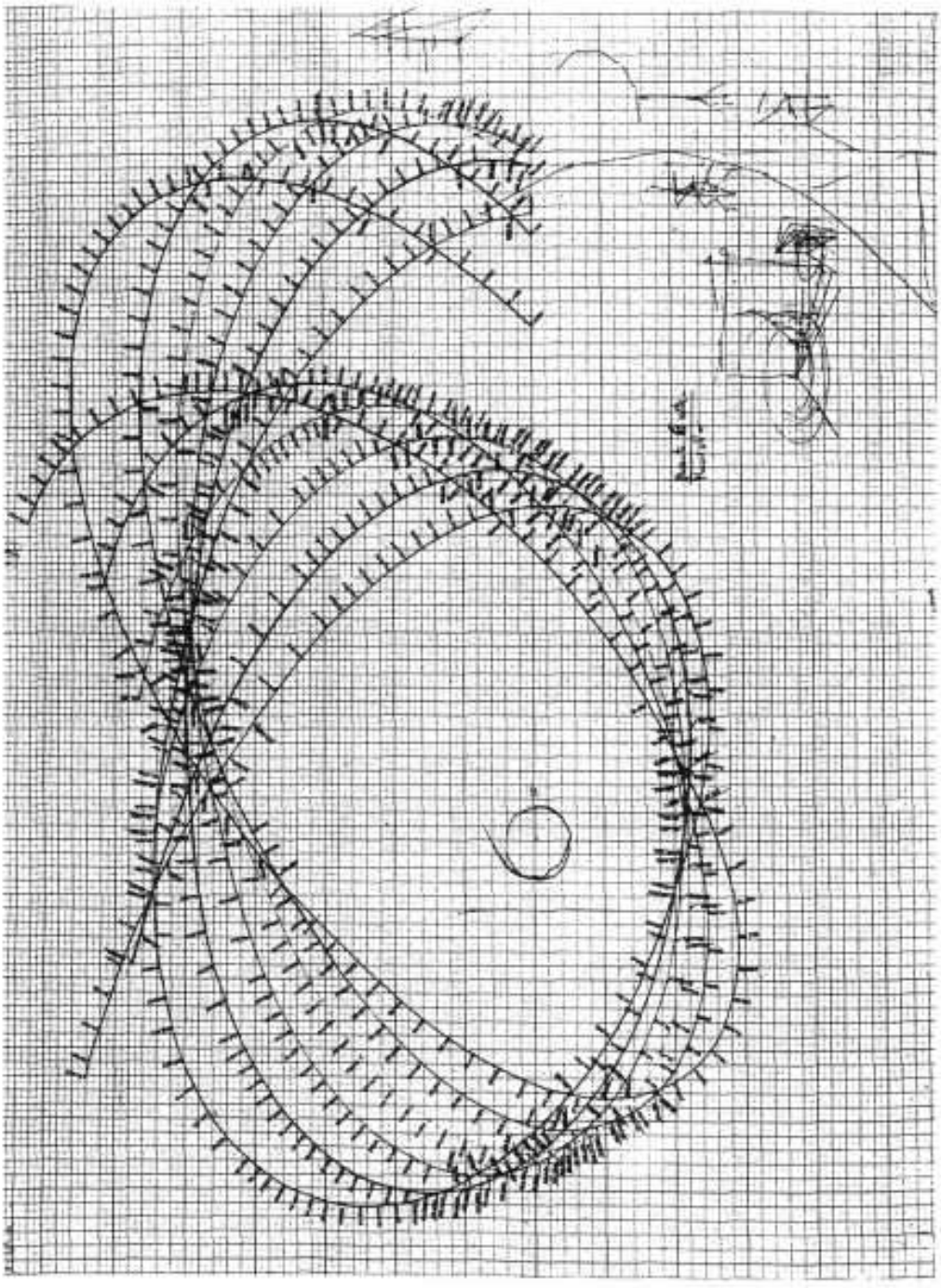
The initiation of this new work has the flavor of a challenge that the sculptor makes to himself, namely to represent the trajectories in a plastic form given their spatial co-ordinates—height, width and length—and to reinterpret them as an aesthetic object, using his own judgement to verify its artistic coherence.

TEST, sculpture by A. Pierelli, photo by S. Takahashi.

The realization of this project seems to be conceptually complex and revolutionary. It is meant to describe a motion, but not a terrestrial one, as the futurists and Boccioni had already done in 1913 with the famous sculpture *Unique forms in space continuity*. Nor should it be the motion of a body set free in the earth's gravitational field, which would fall either vertically or with elliptical or hyperbolic motions. Instead it should resemble a Möbius strip without being so simple, since it would be differentially dragged by the rotational field of the black hole in the geometry of space-time. Hence the acronym TEST which stands for "Traction of Events in Space-Time." Thus the sculpture has no priviledged interpretational directions and no supporting pedestal which might associate it with a central perspective view: no "top" or "bottom," no "right-side" or "left-side." Any orientation gives a complete and faithful realization.

Rather one should imagine it in rotation, with its surface being independent of any relation with the source of natural light ("ambientation" is the fundamental issue of sculpture), ignoring any possible atmospheric effect; in other words, the opposite of a "Mobile" of Calder which awaits a gust of wind to reanimate itself and come alive. Here, the metal light alone outlines and designs the vision of the rotating black hole. The transformation of this sequence of events into a solid form is portrayed by abstracting their properties and reducing everything to a direct perception of its essence, a *Wesenschau*. This representation does not lend itself to psychological or science-fictional interpretation and suggestion; the collective imagination can perceive and attain an emotional projection and exemplification of the universe, of egoism, since it involves a prehensile shape which absorbs and sucks in matter. Moreover, the title TEST, only by pure chance, includes the monogram "ET" which recalls the mythical encounter of a human being with the extraterrestrial of Steven Spielberg's fairy-tale film. There the emblematic image of the finger contact between the two had been borrowed from Michelangelo's *Creation of Man* in the Sistine Chapel while the return to space resembled a mythical ascension on the trail of the Christmas comet.

From a scientific point of view, the clear and lucid form of this sculpture might remind one of the application of mathematical logic to ideographic instantaneity that Giuseppe Peano carried out towards the end of the last century (G.C. Argan, 1985). And from a properly artistic perspective, it can be related to the philosophy of Russian Constructivism around 1920, and to the first clear perception, by Naum Gabo, of the unity of all visible forms and of the existence of aesthetic ones only in accordance with physical and



Three-dimensional trajectories of particles near a Kerr black hole (*Calculations by V. Bellezza and V. Ferrari, drawing by M. Sacripanti*).

mathematical laws.

In the more recent context, characterized towards the late seventies by strong neo-expressionist and subjectivistic artistic movements, or neo-manner-ist re-evaluation of art from the past, interaction with science has meant above all the adoption and use of advanced technologies, the so-called "computer art." However, the use of media totally different from the traditional ones can change only the visual perception of the image and produce only a technical updating of the communication without necessarily yielding a new artistic message. On the other hand a "snapshot" which is new in concept and ichonography can also be expressed through the use of traditional and experimented techniques. Its very novelty may be expressed through the use of modules of different sizes and composition: namely in the form of a 20cm silver object, as in 1985, or in that of a 50cm bronze one, or in steel tubes, like the $340\times470\times260\text{cm}^3$ structure which was shown at the Venice Biennial Exhibition of 1986.

In the silence of his studio the artist finds his knowing craftsmanship, in making the moulds to be forged into metal and in his attempts to achieve the right shape of the torsions which express the intuition of their artistic value, with the light and opacity of the metal. With his mind, he tries not to betray the accuracy promised to the measurements of the curvatures and strives to make them coincide with his own geometric dream.

The discovery of a form which is not an invention, but bears the simple beauty and the perfection of an archetype existing in nature, leads one to re-experience aesthetically the same emotion that must have been felt by whoever discovered it first.

—English translation by Susanna Hirsch

TEST, sculpture by A. Pierelli, photo by S. Takahashi.

Bibliography

A. Imponente, Catalog presentation of the show of A. Pierelli, *TEST, Trascinamento di Eventi Spazio Temporali*, Rome, Galleria MR, September-October (1985).

G.C. Argan, *Conversazione con A. Imponente, A. Pierelli, R. Ruffini*, June (1985).

H.C. Kennedy, *Storia di un matematico* (La Curva di Peano, p.49), P. Boringhieri, Torino (1983).

R. Ruffini, *Stelle, galassie, universo*, catolog of the show *5 Miliardi di Anni*, Rome, Palazzo delle Esposizioni, May-June 1981, Multigrafica Editrice (1981).

V. Bellezza, V. Ferrari, R. Ruffini, M. Sacripanti, *Lo spazio di un buco nero ruotante*, catolog of the show *5 Miliardi di Anni*, Rome, Palazzo delle Esposizioni, May-June 1981, Multigrafica Editrice (1981).

R. Giacconi, R. Ruffini, *Physics and astrophysics of neutron stars and black holes*, North Holland, Amsterdam (1978).

M. Johnston, R. Ruffini, *Phys. Rev.* **D10**, 2324, New York (1974).

R. Ruffini, J.A. Wheeler, *Introducing the black hole*, in *Physics Today*, New York, January (1971).

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Founded by: ICRA, Republic of Armenia, Republic of Italy, University of Arizona, University of Stanford, Vatican State.

Date of foundation: February 10, 2005.

ICRANET promotes international scientific co-operation and undertakes research in the field of Relativistic Astrophysics. Its activities are: development of scientific research; teaching at doctorate and post-doctorate level; long-term and short-term scientific training; organization of workshops and scientific meetings; arrangement of exchange programs for scientists and associates; development of new standards of electronic communication among the Research Centers; establishment of integrated data banks for all celestial bodies in all observable wave bands; co-operation and affiliation with international scientific organizations and technology transfer with industry. Scientific areas covered include cosmology, high-energy astrophysics, theoretical and mathematical physics. ICRANET coordinates the research activities of Member Universities and Research Centers operating in different geographical areas. A series of new seats for the activities are being developed in order to achieve these goals. The first has been completed and it's fully operative in Pescara. The second and the third ones are being established in Nice and Rio de Janeiro. Projects for additional Centres in Stanford (USA), Yerevan (Armenia) and New Zealand are being considered. ICRANET encourages the mobility of scientists among the Centers and offers fellowships to young students at graduate, post-graduate and post-doctoral levels within the framework of special training programs. ICRANET also sponsors the IRAP-PhD doctoral program recognized by the following Universities: ETH Zurich, Freie Universität Berlin, University of Ferrara, Université de Nice Sophia Antipolis, Università di Roma "La Sapienza", Université de Savoie, Stockholm University. The following Research Centers also participate in this program: Einstein Institute in Potsdam, ICRA and ICRANet, IHES in Paris, Observatoire de la Côte d'Azur and Tartu Observatory.

ICRANET is at the service of the scientific institutions and the Member States that wish to co-operate in the field of Relativistic Astrophysics.