*Università di Roma "Tor Vergata"*
*Villa Mondragone, September 21, 2010*

# Laurea Honoris Causa a

# Isadore M. Singer

Laudatio delivered by R. Longo

## A historical place for Mathematics and Physics


LVNARIO
NOVO. SECONDO LA NVOVA RI-
FORMA DELLA CORRETTIONE DEL L'ANNO.
RIFORMATO DA N. S. GREGORIO XIII.

In this place Pope Gregorio XIII signed and proclaimed the papal Bull Inter Gravissimas, in 1582, giving birth to the new calendar, using the observations of C. Clavius and J. Kepler. An early example of *Mathematical Physics*.

## A great scientist for Mathematics and Physics


In this place we are offering the Laurea Honoris Causa to *Isadore M. Singer*, one of the greatest Mathematician of the 20th century.

## Early mathematical work

I. Singer begins his career together with Richard V. Kadison as pioneers in *Operator Algebras*,

the new infinite-dimensional mathematical structure just introduced by John von Neumann motivated by *Quantum Mechanics*, now a fundamental mathematical subject.

The Kadison-Singer problem, for example, is still nowadays subject of vital research activity.

**The celebrated Atiyah-Singer Index Theorem (1963)**

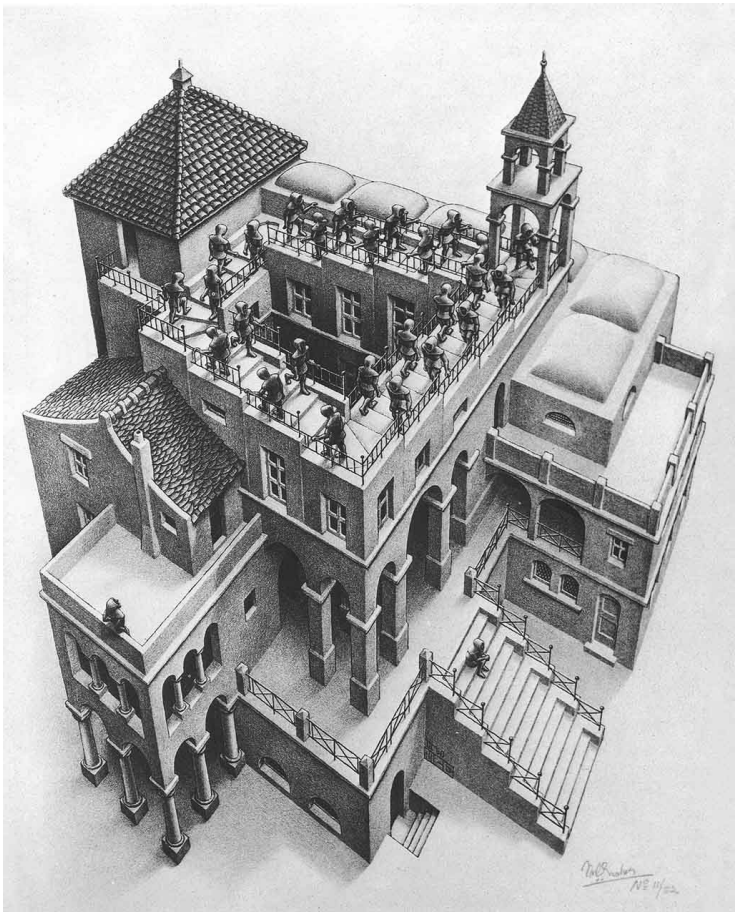
**Theorem.** $P$ an elliptic differential operator defined over a compact oriented manifold:

$$\boxed{\text{analytical index}(P) = \text{topological index}(P).}$$

The analytical index is related to the number of solutions of $P = O$, the topological index is deformation invariant.

*The Index Theorem provides an astonishing bridge between Analysis and Geometry and represents a milestone in Mathematics.*

## A simple example



A simple case is illustrated by a famous paradoxical etching of M.C. Escher, "Ascending and Descending", where the people, going uphill all the time, still manage to circle the castle courtyard. The index theorem would have told them this was impossible. (MIT web site)

## The Berkeley seminar (1977)

In 1977 Isadore Singer started a seminar relating

$$\text{Mathematics} \longleftrightarrow \text{Theoretical Physics}$$

*The Index Theorem provides an astonishing bridge between Mathematics and contemporary Physics (Gauge theory, etc.) and is a fundamental tool in Theoretical Physics.*

The Berkeley seminar continues to be very influential both in Mathematics and Physics.

## Recent extensions of the Index Theorem

The Index Theorem is still a source of inspiration for Mathematical and Physical research in various directions. Among its various generalizations, A. Connes has extended it to the *Noncommutative Geometry* context, by the Operator Algebraic point of view.

## Notable awards

- Bôcher Memorial Prize (1969)
- National Medal of Science (1983)
- Wigner Medal (1988)
- Steele Prize (2000)
- Abel Prize (2004)