



THE VATICAN OBSERVATORY OFFERS A LECTURE SERIES ON THE FOUNDATIONS OF QUANTUM GRAVITY

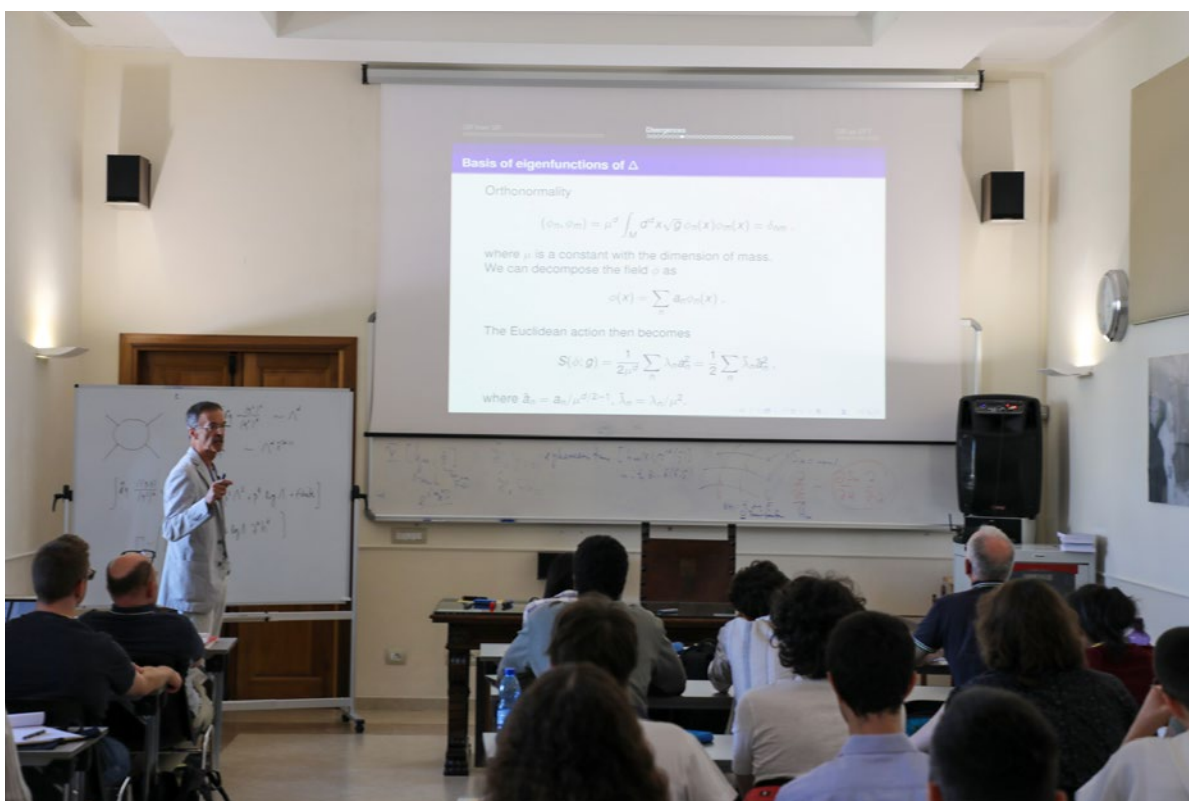
In recent days, the Vatican Observatory — the astronomical observatory of Vatican City State — has been hosting a series of lectures at its Castel Gandolfo headquarters dedicated to one of the most fascinating problems in modern physics: the Vatican Observatory Lectures on Quantum Gravity 2026. Internationally renowned experts are guiding a group of PhD students and young researchers through the problem of quantum gravity: how to unify quantum mechanics, which governs the world of elementary particles, with Albert Einstein's general relativity, which describes gravity and the structure of spacetime on large scales. This theory should explain the origin and earliest moments of the Universe we live in. The central difficulty is this: in general relativity, space and time are not a fixed stage on which physics unfolds, but are themselves protagonists — they curve, deform, and take part in the dynamics. When one tries to apply the rules of quantum mechanics to these quantities, deep mathematical inconsistencies arise. The best known is so-called perturbative non-renormalizability: in the language of theoretical physics, “renormalizing” means keeping under control the infinite quantum corrections that appear in calculations by absorbing them into a finite number of experimentally measurable parameters. This procedure, which works perfectly for the other forces of nature, fails in the case of gravity: quantum corrections proliferate uncontrollably, generating an infinite number of free parameters that leave the theory unable to make predictions. Finding a way around — or a solution to — this problem is one of the main goals of research in quantum gravity.

The lecture series — coordinated by Fr. Gabriele Gionti, SJ, and Fr. Matteo Galaverni of the Vatican Observatory — explores four approaches to this problem. Professor Claus Kiefer (University of Cologne) presents the canonical quantization of gravity and the problem of time: in a theory where time itself is a dynamical variable subject to quantum fluctuations, how is the evolution of a physical system to be

defined? Kiefer also addresses open questions concerning black holes — objects in which gravity reaches extreme intensities — and their quantum description, including the nature of the singularities within them. Professor Roberto Percacci (SISSA, Trieste) shows how to quantize gravity in a covariant way, treating gravitons — the quanta of the gravitational field, analogous to photons for light — as spin-2 particles. He also introduces the asymptotic safety program, an elegant proposal suggesting that gravity could become quantum-mechanically consistent through a particular behavior of its fundamental constants at high energies, without the need for new exotic ingredients. Professor Sergio Cacciatori (University of Insubria) tackles the more subtle conceptual difficulties: what does it mean to quantize a theory in which the very arena of space and time is itself subject to quantum uncertainty? How is time measured when time itself is fluctuating? These are questions that may sound philosophical but carry precise technical consequences that remain unresolved to this day. Professor Pierpaolo Mastrolia (University of Padua), for his part, brings the perspective of scattering amplitudes — the mathematical tools physicists use to calculate the probability that two particles collide and give rise to new particles. Mastrolia points out striking structural analogies between the amplitudes of gauge theories — which describe the electromagnetic and nuclear forces — and those of quantum gravity, particularly supergravity and string theory, opening up unexpected connections between seemingly distant areas of theoretical physics.

These lectures thus offer participants a truly unique experience. The Vatican Observatory, a centuries-old institution that has always combined scientific rigor with intellectual openness, offers these young researchers not just a place to study, but an atmosphere in which free exchange and curiosity remain central. Because the great open questions — and the quantum nature of space and time is certainly among the greatest — are best tackled together.





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