Course Unit – Epistemology and Philosophy of Science
7,5 ECTS – 2nd level (Master's Degree)
2022- 2023, 1st Semester
Instructors: Adriana Silva Graça (coord.), Davide Romano
Language of Instruction: English

1st Module – Analysis of Knowledge (Adriana Silva Graça)

This model will deal with issues around the analysis of knowledge such as the traditional analysis and the main objections to it. The standard responses --known as internalist and externalist ones-- will be discussed. Finally, philosophical approaches as the virtue epistemology and "knowledge first" will be addressed.

Reading Materials:

Plato, Theaetetus.
A.J. Ayer (1956), *The Problem of Knowledge* (v) Knowing as Having the Right to be Sure.
E. Gettier (1963), "Is Justified True Belief Knowledge?"
R. Audi (2011), *Epistemology. A Contemporary Introduction to the Theory of Knowledge*. Routledge.
D. Pritchard (2018), *What Is This Thing Called Knowledge?*. Routledge.

2nd Module - Philosophy of quantum mechanics: what does quantum mechanics tell us about the physical world? (Davide Romano)

The course will investigate the novel features of the physical world as they emerge from quantum mechanics. It will be divided into three parts. In the first part, the course will provide an introduction to the formalism of quantum mechanics. This will include the collapse of the wave function and the measurement problem, which is at the heart of many quantum paradoxes such as the two-slit experiment and the Schrödinger's cat. In the second part, the course will focus on the principal interpretations of quantum mechanics that have been advanced and proposed in the last decades: the de Broglie--Bohm theory or pilot-wave theory, the GRW--spontaneous collapse theory, the Everett--Many Worlds Interpretation and Rovelli's relational interpretation. In the third part, the course will focus on the meaning of the Heisenberg uncertainty principle and the emergence of the classical world—classical objects well-described by Newton's theory--from quantum mechanics. Previous knowledge in physics is not necessary: the needed formalism will be introduced and presented during the lessons.

Program:

1. Introduction to the quantum formalism: Hilbert's space, the state vector, the wave function, eigenstates and eigenvalues, operators and observables, the collapse of the wave function, the Schrödinger equation.
2. The measurement problem: Schrödinger's cat, the two-slit experiment.
3. Interpretations of quantum mechanics I: the de Broglie-Bohm theory, the GRW theory.
4. Interpretations of quantum mechanics II: the Everett theory, Rovelli's relational interpretation.
5. The Heisenberg's uncertainty principle: standard/ontic vs statistical/epistemic interpretation
6. Decoherence and the classical limit of quantum mechanics: the emergence of classical objects.

Syllabus

1st week: The formalism of quantum mechanics.

2nd week: The measurement problem

3rd week: Interpretations of quantum mechanics I

4th week: Interpretations of quantum mechanics II

5th week: The Heisenberg's uncertainty principle

6th week: Decoherence and the quantum-to-classical transition

Reading Materials

- L. E. Ballentine (1970), The statistical interpretation of quantum mechanics, *Reviews of Modern Physics*.
- G. E. Bowman (2008), *Essential Quantum Mechanics*, Oxford University Press, Oxford.
- T. Maudlin (2019), *Philosophy of Physics: Quantum Theory*, Princeton University Press.
- T. Norsen (2017), *Foundations of Quantum Mechanics*, Springer, Berlin.
- D. Romano (2021), On the alleged extra-structures of quantum mechanics, *Foundations of physics* 51(29).
- D. Romano (2022), The unreasonable effectiveness of decoherence, forthcoming in *Quantum Mechanics and Fundamentality* (V. Allori, editor), Synthese Library, Springer.
- C. Rovelli, The relational interpretation of quantum physics, to appear in the *Oxford Handbook of the History of Interpretation of Quantum Physics*. Preprint available on-line at: https://arxiv.org/pdf/2109.09170.pdf
- C. Rovelli, Space is blue and birds flight through it, *Philosophical transactions of the Royal Society*, 2018. Preprint available on-line at: https://arxiv.org/pdf/1712.02894.pdf
- M. Schlosshauer, *Decoherence and the Quantum-to-Classical Transi*

Grading and Assessment:
Students are expected to write a final essay (around 4000 words) in one of the modules (40% of the final grade) and to make one written test for each module (60% of the final grade). Depending on the instructors' choice and on the number of students in class, oral presentations may be included.