UNIVERSITÀ DI PAVIA

Anno Accademico 2017/2018

THEORETICAL PHYSICS OF INFORMATION

Enrollment year	2016/2017
Academic year	2017/2018
Regulations	DM270
Academic discipline	FIS/03 (MATERIAL PHYSICS)
Department	DEPARTMENT OF PHYSICS
Course	
Curriculum	Fisica teorica
Year of study	2°
Period	1st semester (02/10/2017 - 19/01/2018)
ECTS	6
Lesson hours	48 lesson hours
Language	Italian, or English if needed.
Activity type	ORAL TEST
Teacher	PERINOTTI PAOLO (titolare) - 4 ECTS PERINOTTI PAOLO (titolare) - 2 ECTS
Prerequisites	The student is expected to know the basic mathematical structure of probability theory and quantum theory. The required notions will be anyway reviewed in the first lectures of the course.
Learning outcomes	Learning the basic topics of information theory: compression and transmission over classical and quantum channels.
Course contents	The course covers the key topics of classical and quantum information theory, with particular focus on the issues of compression and error correction that lie at the core of the notion of information itself. Part 1: Classical information. After introducing the basic concepts, some encoding schemes are shown, along with compression and error correction schemes, with measures of information, Shannon entropies, mutual information and their properties. The two Shannon theorems are proved: source coding and noisy channel coding. Finally, McMillan's

	bound, Fano's inequality and the data-processing theorem are shown. Part 2: Classical information over quantum systems. Quantum von Neumann entropies are introduced and their properties are proved, as well as Lieb's theorem and Uhlmann's monotonicity for relative entropy. Quantum accessible information is then introduced, and Holevo's theorem is proved. Part 3: Quantum Information. This part of the course is opened by the analysis of reliable quantum compression, introducing fidelity and entanglement fidelity. Schumacher's quantum source coding theorem and quantum Fano's inequality are proved. Coherent information and quantum data-processing theorem are exposed, and finally the general theory of quantum error correction is presented.
Teaching methods	The course consists in blackboard lectures.
Reccomended or required readings	I. K. Chuang and M. A. Nielsen, Quantum Information and Quantum Computation, Cambridge University Press, (Cambridge UK 2000) D. J. C. MacKay, Information Theory, Inference, and Learning Algorithms, Cambridge University Press (Cambridge UK 2001) T. M. Cover, J. A. Thomas, Elements of Information Theory, John Wiley & Sons (Hoboken USA 2012)
Assessment methods	The examination is oral. The student is expected to master the topics of the course, and to solve elementary problems. The first topic is chosen by the student. Then the exam consists in a few questions aimed at ascertaining completeness of preparation.
Further information	The examination is oral. The student is expected to master the topics of the course, and to solve elementary problems. The first topic is chosen by the student. Then the exam consists in a few questions aimed at ascertaining completeness of preparation.
Sustainable development goals - Agenda 2030	$lbl_legenda_sviluppo_sostenibile