



INSTITUT DE FRANCE  
Académie des sciences

## Des Associés étrangers de l'Académie des sciences présentent leurs recherches

**Mardi 15 juin 2010 de 9h à 12h15**

(Institut de France – Grande salle des séances – 23 quai de Conti – 75006 Paris)

**Organisation Odile MACCHI,  
Déléguée de la section des Sciences mécaniques et informatiques**

### RÉSUMÉS DES CONFÉRENCES

**Compressed Sensing:  
High-Dimensional Geometry speeds up Medical Imaging and Genomic Analysis**

**David DONOHO, USA**  
*University of Stanford,  
Section de Mathématiques*

Every schoolboy is taught that systems of equations with more unknowns than equations are 'unsolvable'. The last ten years have shown that when the solution is known to be sparse - i.e. relatively few nonzero entries - it can be found reliably, stably, and quickly. Impacts are being felt in several scientific fields, speeding up pediatric Magnetic Resonance Imaging by a factor of 8 and certain gene sequencing problems by factors of 30. Geometry of projections of high-dimensional convex bodies gives the intellectually clearest explanation.

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### **Quantum Information and the Foundations of Quantum Mechanics**

**Anton ZEILINGER, Austria**  
*Institute of Quantum Optics and Quantum Information, Vienna,  
Section de Physique*

Quantum information science, having emerged from experiments testing the foundations of quantum physics, is giving rise to a renewed debate about just these foundations. Most notably entanglement, dismissed as "spooky" by Einstein while called "the characteristic trait of quantum mechanics" by Schrödinger emerged both as a central fundamental concept and as important, in cases even crucial, for procedures like quantum cryptography, quantum computation, and quantum teleportation. Today entangled states can cover large distances, for example between two Canary Islands, employ a significant number of particles and many different kinds of degrees of freedom, internal and external. The resulting development of experimental tools opened up possibilities for new experiments shedding more light on fundamental questions. The emerging picture is that the notion of information itself plays a fundamental role in the understanding of quantum mechanics.

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*De revolutionibus stellarum neutroniis compactarum gammaradios emmittentium*  
**Or A High-Energy Revolution in the Sky**

**Giovanni F. BIGNAMI, Italia**  
*Istituto Universitario di Studi Superiori di Pavia*  
*Section des Sciences de l'univers*

It all started 40 years ago, soon after the radio pulsar discovery, as soon as space astronomy came of age. Rotating neutron stars (NSs) emit the vast majority of their energy in gamma-rays, more so than in X-rays. Not only that: after the first case of Geminga, the Fermi Observatory is telling us that many, may be the majority, of NSs in our Galaxy emit *only* in gamma-rays and are invisible at other wavelengths. Such a high-energy revolution will lead us to the understanding of NS physics.

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**Mathematics of Metamaterials**

**John WILLIS, United Kingdom**  
*Cambridge University*  
*Section des Sciences mécaniques et informatiques*

There is no unique definition but for the purpose of this talk a metamaterial is a composite material whose microstructure is specifically designed so as to accentuate response that is not observed in materials that occur naturally. Examples include materials with negative “effective density” (over some range of frequencies) and materials with negative index of refraction. They offer the possibility of devices such as lenses with sub-wavelength resolution, and even the possibility of surrounding an object with a “cloak” that renders it invisible. The methods that need to be employed for analysis of constitutive response are basically the same as those required for any type of composite, except that the effects of interest are associated with dynamic response, for which theory is less developed than in the case of statics. At the present time there is not even complete agreement among the large and growing “metamaterials community” about the correct definition of effective dynamic response. The current state of play will be reviewed.

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**Le bilan d'eau en pays aride, une recherche permanente.**

**Mustapha BESBES, Tunisie**  
*École nationale d'ingénieurs de Tunis*  
*Inter-section des applications des sciences*

Le bilan d'eau des pays arides est déterminé par la prééminence des eaux souterraines et l'importance de l'évapotranspiration, deux systèmes de flux difficilement accessibles à la mesure directe, domaines de prédilection des incertitudes, et secteurs d'applications scientifiques multidisciplinaires, où se conjuguent les outils de l'analyse quantitative et qualitative. L'acquisition systématique et le traitement de l'information, la modélisation, deviennent alors les instruments incontournables de la connaissance du bilan hydrique, et de la médiation avec l'utilisateur. Les pays arides sont certes définis par la rareté de l'eau, mais les concepts de pénurie et de stress hydrique acquièrent une nouvelle perspective lorsque le paradigme du bilan hydrique est élargi à toutes les formes de ressources en eau. La rareté n'est pas fatalement source de pénurie, dès lors que tous les acteurs prennent la juste mesure du risque.