Compressed Sensing: from Cosmology to Magnetic Resonance Imaging
Dr. Jean-Luc Starck (CEA-Saclay, France)

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Radio interferometry is a technique by which the signal of a plane wave from a distant source is collected simultaneously by multiple telescopes and later combined, taking into account the difference in the path between the astronomical source and each radio telescope. The discrete nature of the signal has recently been interpreted by our team through the ``Compressed Sensing'' (CS) acquisition theorem. The CS approach supports the idea of using a specific mechanism, called sparsity, in order to reconstruct 2D images from the measured data. In Magnetic Resonance Imaging (MRI), similar type of observations are being made – sampling the signal from many discrete directions - thus providing an opportunity for new types of MRI imaging acquisition and reconstruction techniques.

We will first briefly introduce the concept of CS and sparsity, followed by a demonstration on how the resolution of a radio-astronomy image can be improved by a factor four, compared to the current state-of-art. Then, we will present novel MRI acquisition schemes developed for the NeuroSpin MRI instrument of CEA, which is about to achieve a strength of 11.7 Tesla later this year. Using such CS acquisition techniques, similar to those developed for our astrophysical reconstruction methods, allows superb resolution in the reconstructed image, with a significant acceleration of the MRI acquisition time. Results using real MRI measurements will be presented.

Note:
The Colloquium is presented in the context of the Workshop on Computational Intelligence in Remote Sensing and Astrophysics, which is organized at FORTH for a 2nd year, by the Signal Processing Lab of ICS/FORTH (http://spl.edu.gr)

Brief Biography

Dr. Jean-Luc Starck is Director of Research at CEA-Saclay, France. He holds a Ph.D from Nice Observatory and a Habilitation from the University Paris XI. In 2010 he founded and has been leading since, the "CosmoStat lab" at CEA, an interdisciplinary research group, currently having 25 researchers. The group is working at the research interface between astrophysics, cosmology and statistics, with strong interests in applications, by developing close industry-academia partnerships. He has been a frequent visitor of several institutions, including the European Southern Observatory, UCLA, Stanford, the Flatiron Institute, and FORTH. Dr. Starck is a fellow of the International Astrostatistics Association since 2016. He has received the EADS Prize of the French Academy of Science in 2011, as well as the 2018 Gruber Price in Cosmology (as a member of the ESA Planck team). Over the last 10 years, he has been involved as Co-I or PI in the management of ~8MEuros in competitive research funding from French, European and international sources, including an Advanced ERC. He has published over 350 refereed papers in astrophysics, cosmology, signal processing and applied mathematics, which have received more than 40,000 citations (source Google Scholar), and he is also author of three books. Currently, he is mainly interested in various aspects of cosmology and he is heavily involved in the Euclid space mission of ESA, which will be launched in 2022.
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