Super-resolution Spectroscopy

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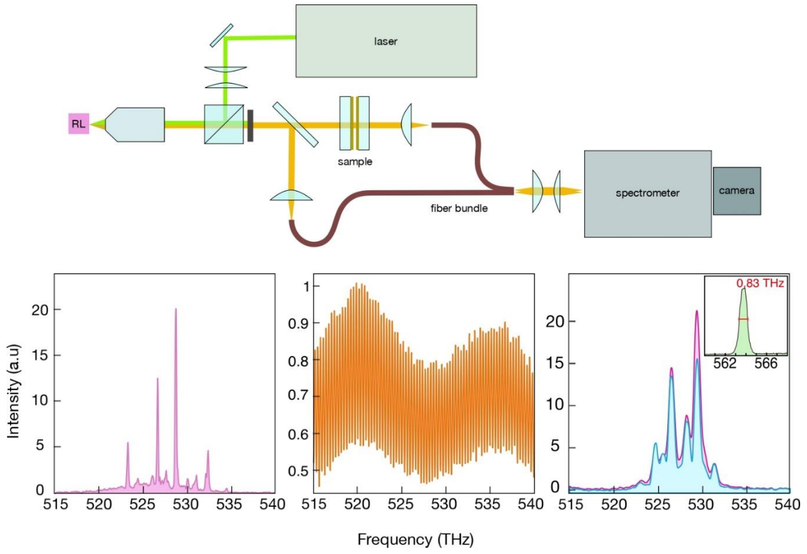
Invention

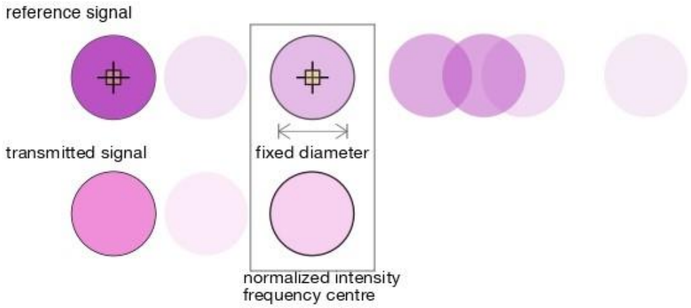
The patent protects the first experimental demonstration of super spectral resolution spectroscopy obtained using a random laser light source. In analogy with super-resolution stochastic microscopy techniques (Nobel Prize in Chemistry 2014), we exploit this effect to enable a spectral characterization that exceeds the instrumental resolution of a dispersive spectrometer and is limited only by the intrinsic spectral amplitude of the laser modes. .

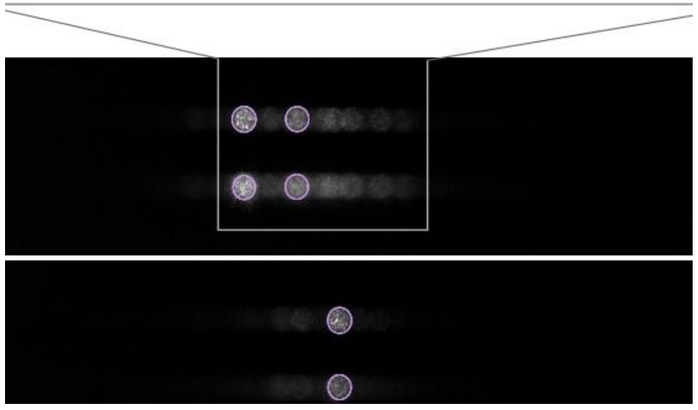
The patented technology introduces the idea of scattered sampling in the frequency domain into spectroscopy, using random lasers as the light source. In this way it is possible to obtain a super resolution in the spectroscopic characterization of the analyzed samples, i.e. a finer characterization of the nominal resolution of the spectrometer. Sparse sampling allows to recover the transmission function of the target, as well as a super resolution microscopy image, using a random laser in the chaotic regime as the illumination source, which allows to obtain a few narrow, well-defined "peaks". separated from each other, with the emission spectrum of each laser pulse completely unrelated to the previous pulse. By having only a few prominent peaks for each laser spectrum, a reconstruction of the super-resolved target spectrum, free from deconvolution artifacts, becomes possible. The invention consists of an optical apparatus comprising a spectrometer and a random laser source, and a statistical analysis method based on the stochastic central frequencies of the laser transmission modes of disordered active media. On the other hand, strong intensity fluctuations between different laser modes are normalized by synchronously monitoring a fraction of the unfiltered random laser spectrum.

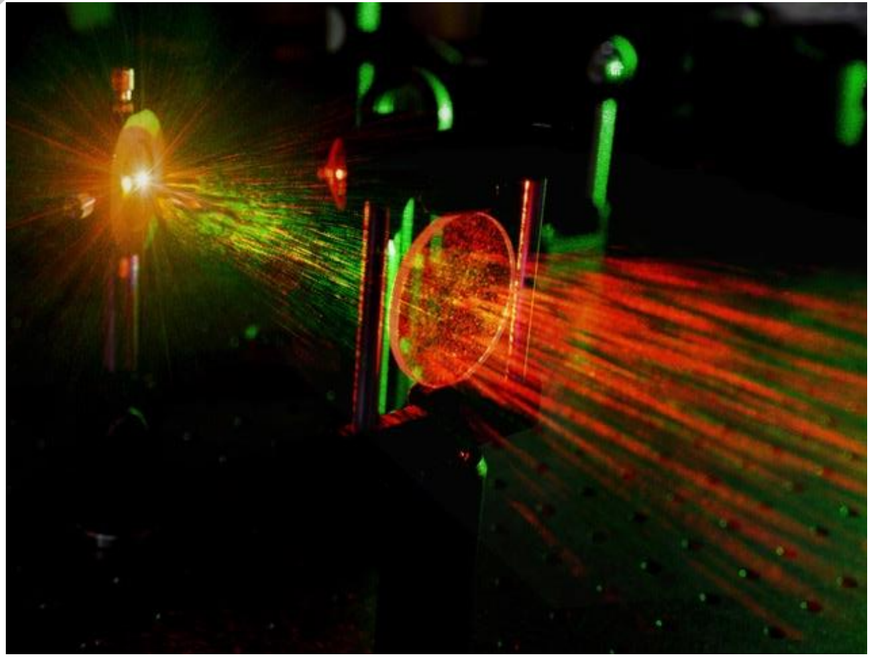
The patent is in joint ownership with LENS - European Non-Linear Spectroscopy Laboratory

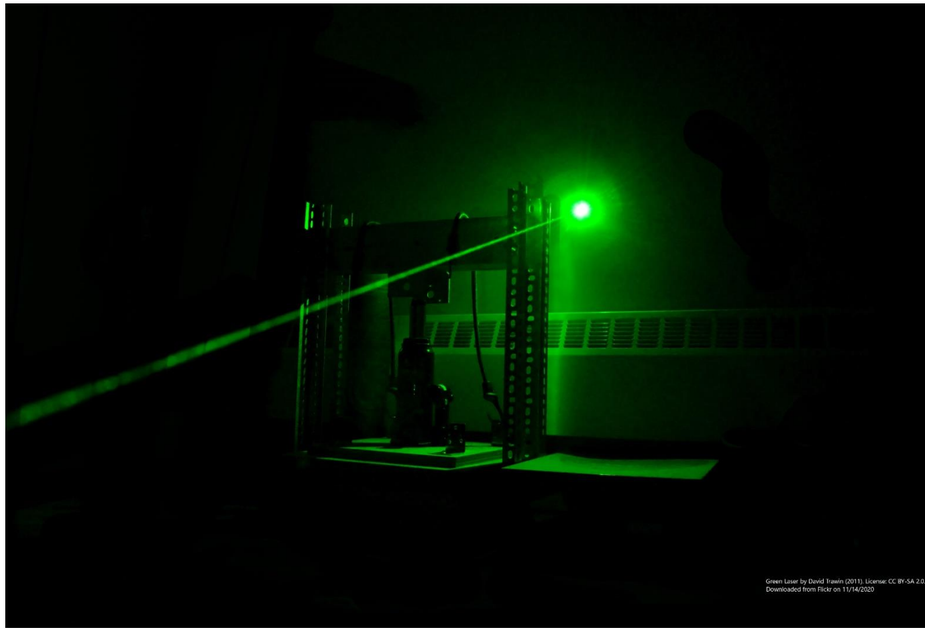
Drawings & pictures











Industrial applications

The invention finds application in all those industrial sectors that need to exploit the intrinsic properties of the random laser in its chaotic regime, for the stochastic and sparse frequency sampling of the target spectrum, for the statistical reconstruction of the super-resolved transmission function and for independence from the spectral resolution of the instrument.

The main advantages of the invention consist in the higher spectral resolution obtained in place of the nominal resolution of the instrument and in the greater robustness at low signal / noise levels compared to processing based on deconvolution. The method is also based on extremely economical light sources, based on simple random laser devices and is therefore generally applicable to all spectral ranges in which a random laser is available.

Possible developments

The patent is available for exclusive and non-exclusive assignment or license. The licenses are available for the entire remaining term of the patent titles.

The research group is available for new research activities in collaboration and on behalf of third parties, technical insights, scientific advice, also aimed at raising the TRL of technology.

The TRL of the invention is 4.

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