

Advanced Raman spectroscopy and imaging in Nanomedicine

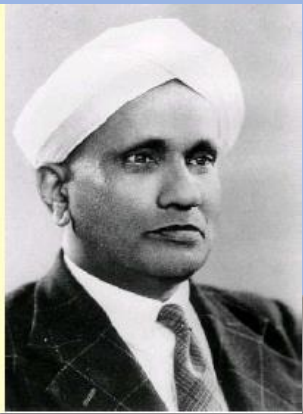
Chair: Fabrizio Giorgis

*Dept. of Applied Science and Technology
Politecnico di Torino, Torino, ITALY*



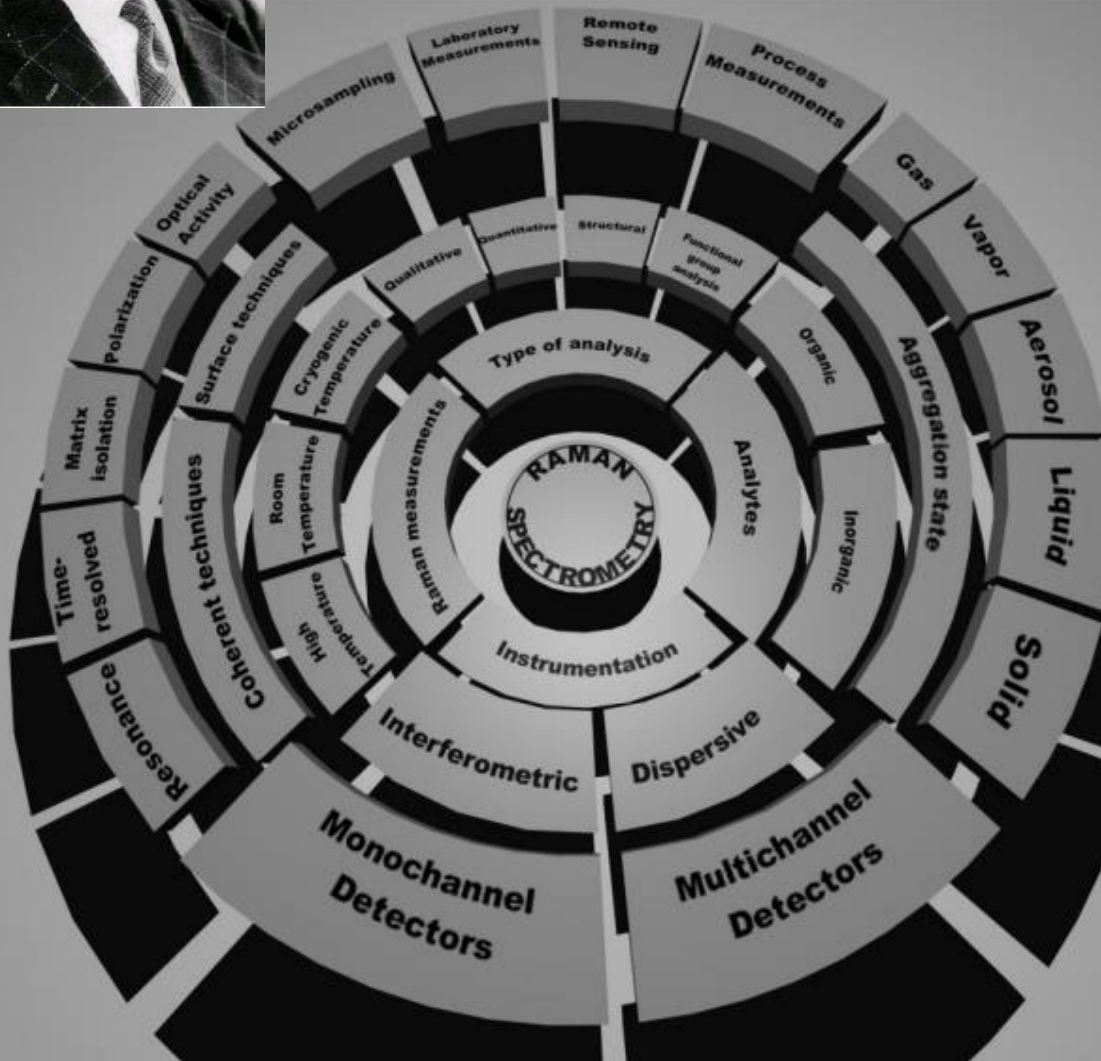
RENISHAW 
apply innovation™

Nano Rome, 20-23 September
2016 Innovation
Conference & Exhibition



1928 (discovering) → 1930 (Nobel prize)

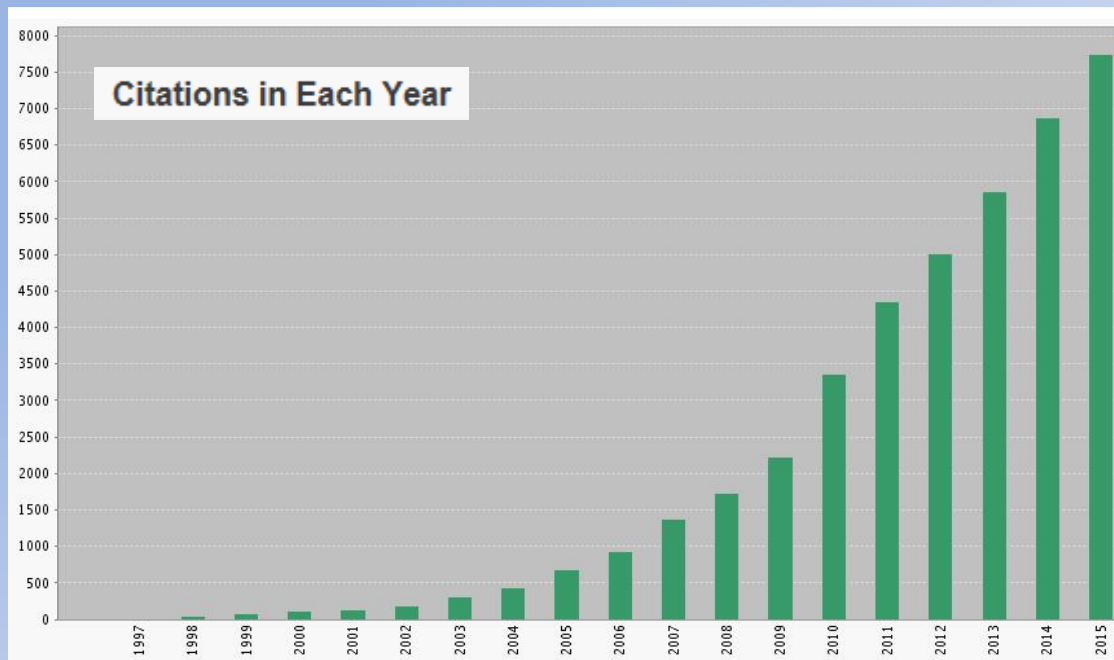
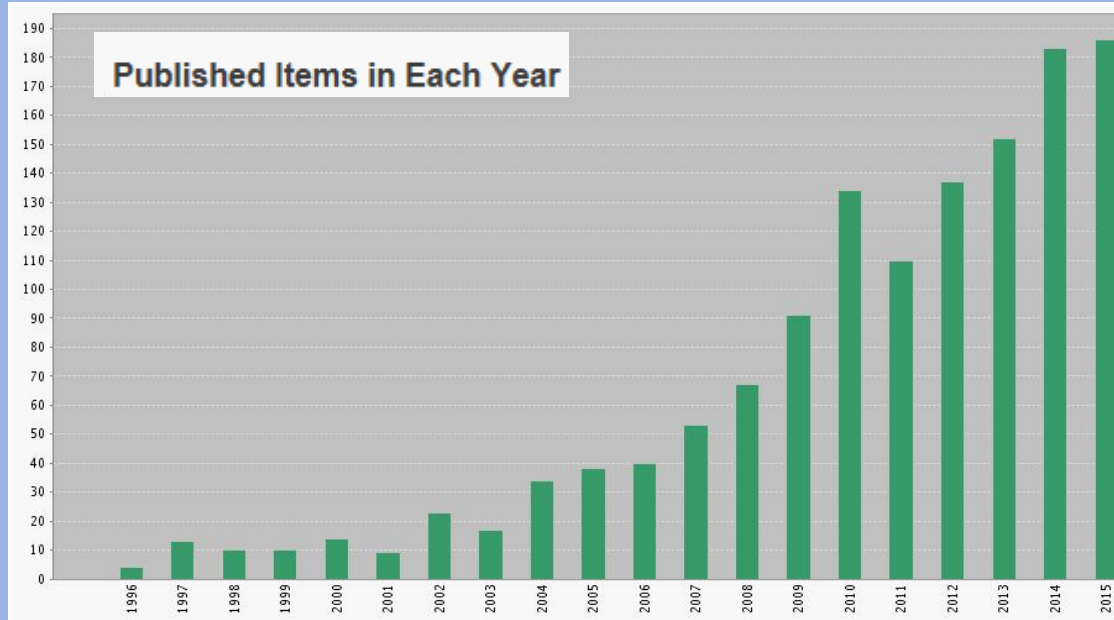
Sir Chandrasekhara Venkata Raman



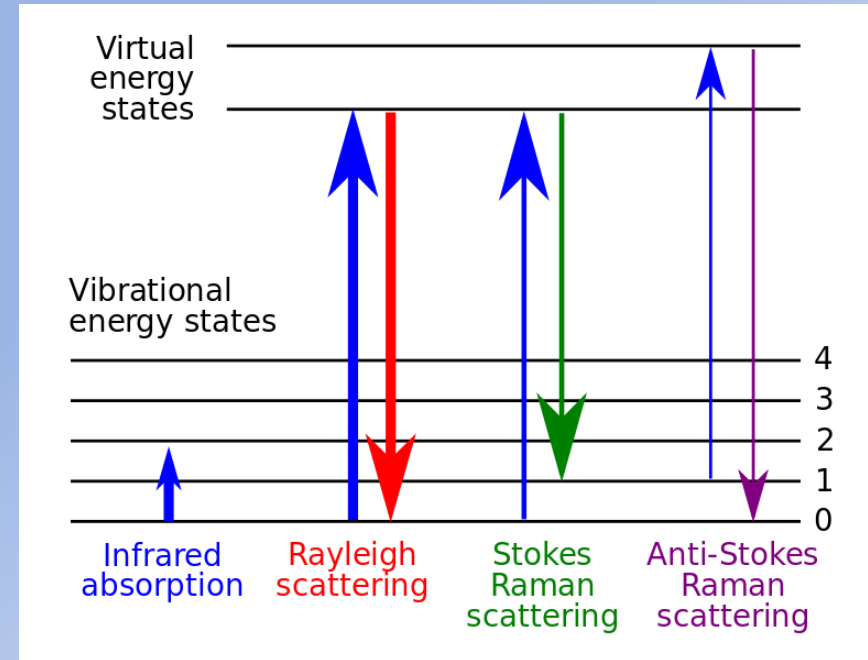
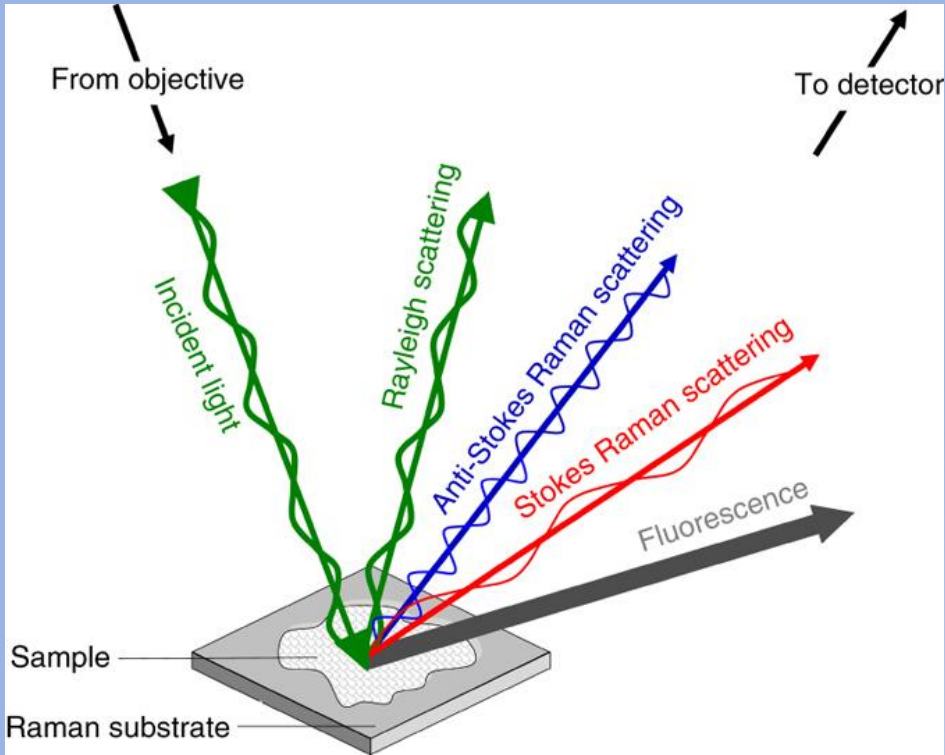
Applications:

- **Material Science**
- **Environmental Sciences**
- **Art, Jewellery and Forensic Science**
- **Biology, Biophysics and Medicine** → **Nanomedicine**

Publications on Raman & Medicine/Biology

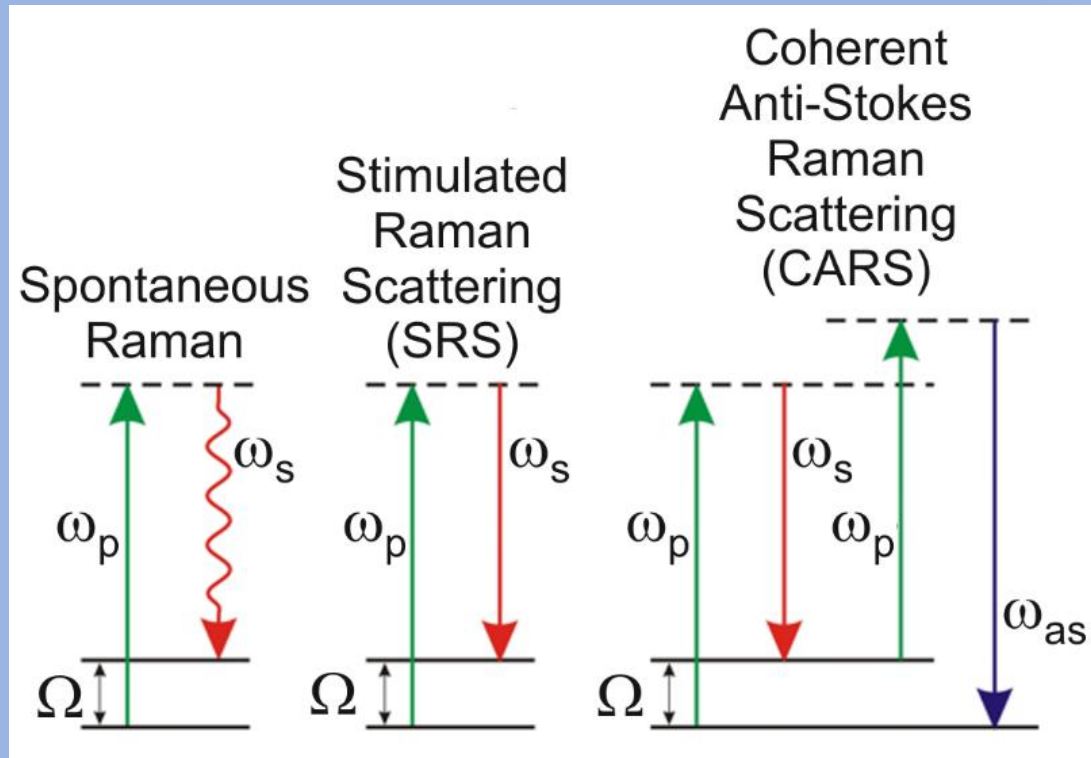


The Raman approach for detection



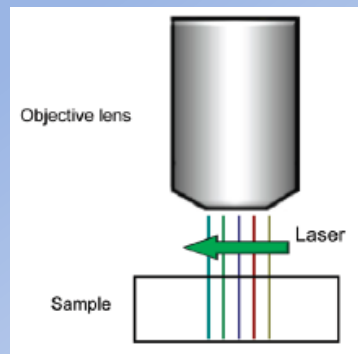
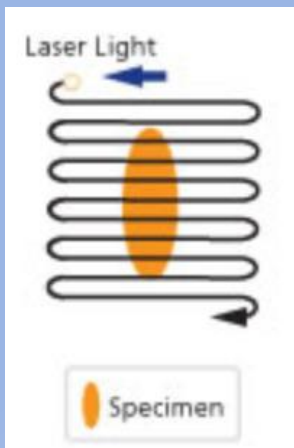
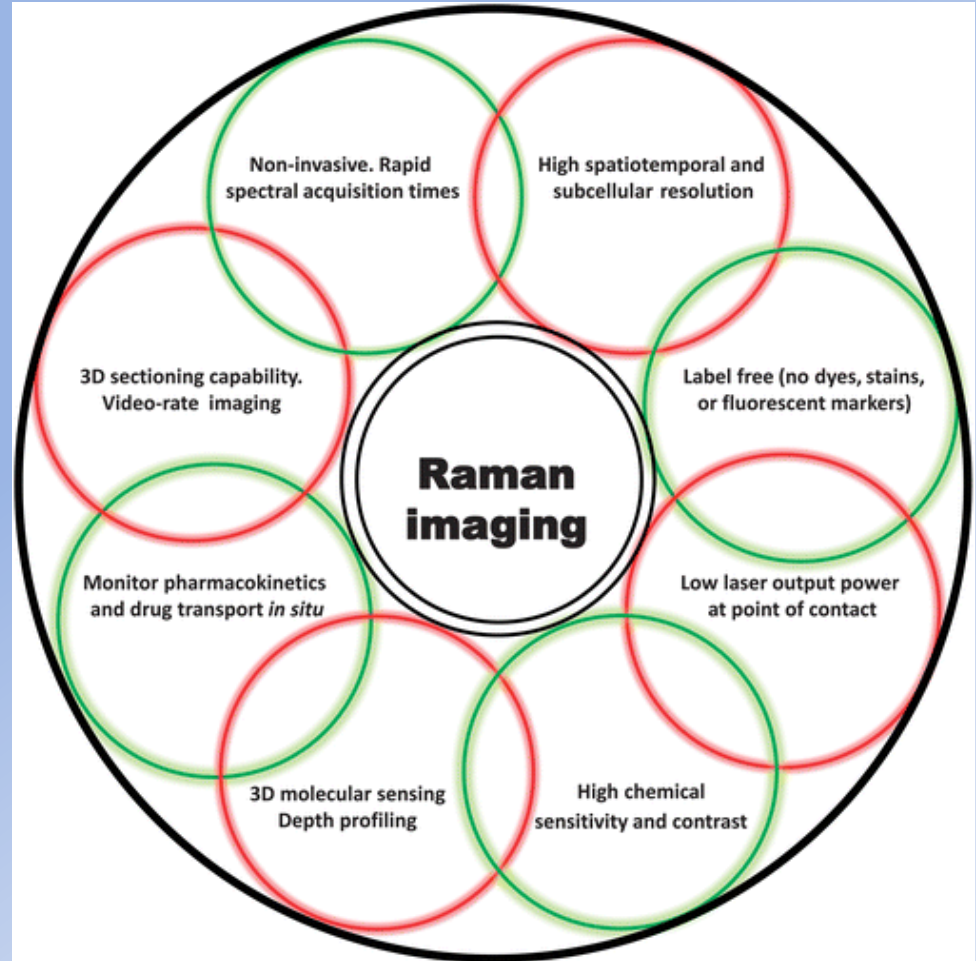
- Non invasive, Label-free technique
- Very low efficiency of the spontaneous Raman process
(Raman cross section \ll 12 orders of magnitude lower than the absorption/fluorescence cross section)

Coherent Raman Scattering (CRS) techniques



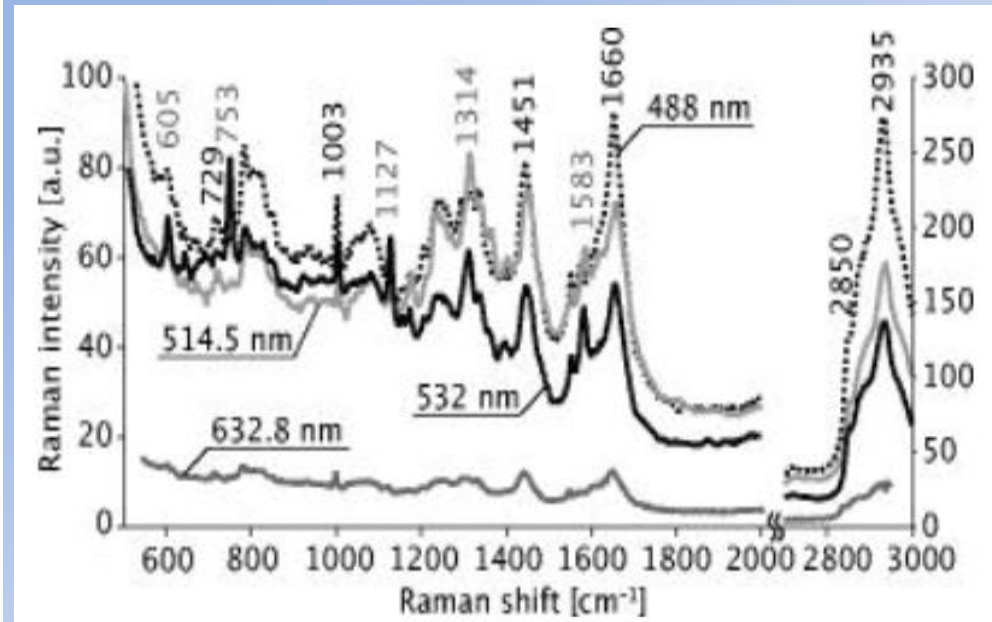
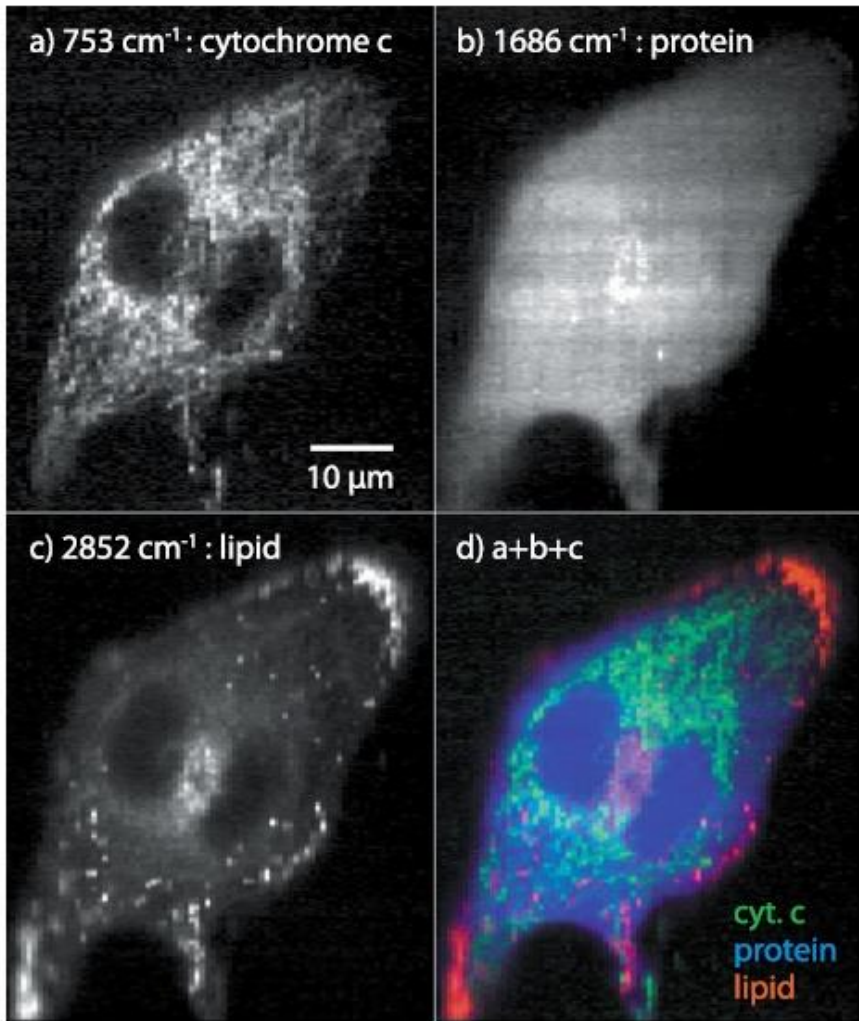
- Vibrational coherence enhances the Raman response by many orders of magnitude with respect to the incoherent spontaneous Raman process
- CRS exploits a coherent superposition of the vibrational responses from the excited oscillators, it is considerably more sensitive than spontaneous Raman microscopy, allowing extremely higher imaging speeds, up to the video rate

Raman spectroscopy for in vitro & in vivo imaging

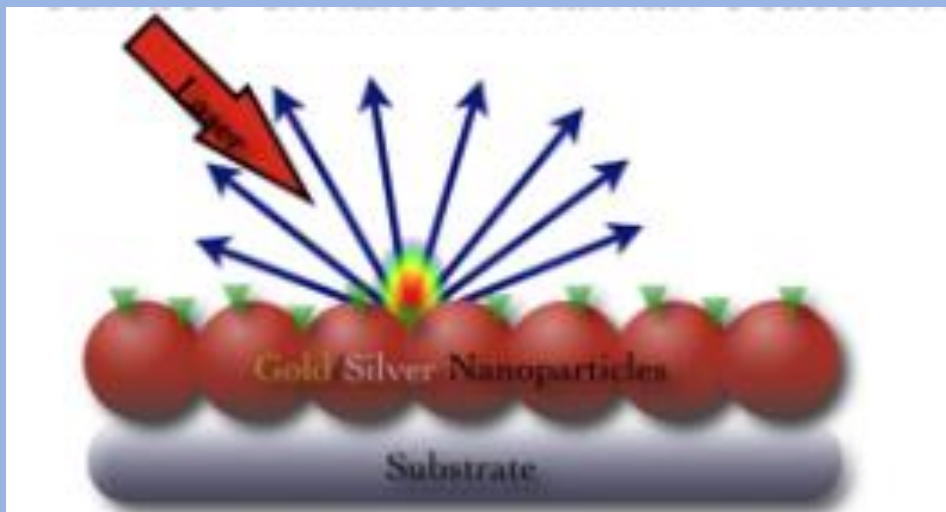


Raman imaging

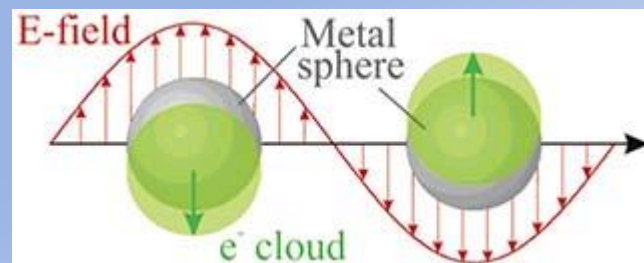
In vitro imaging on cervical cancer cells



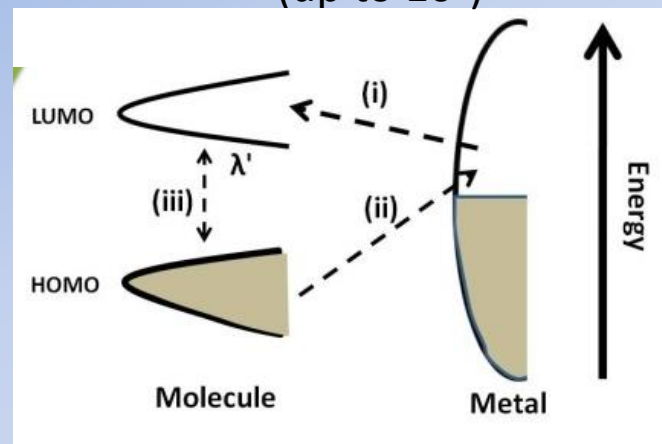
Surface enhanced Raman scattering (SERS)



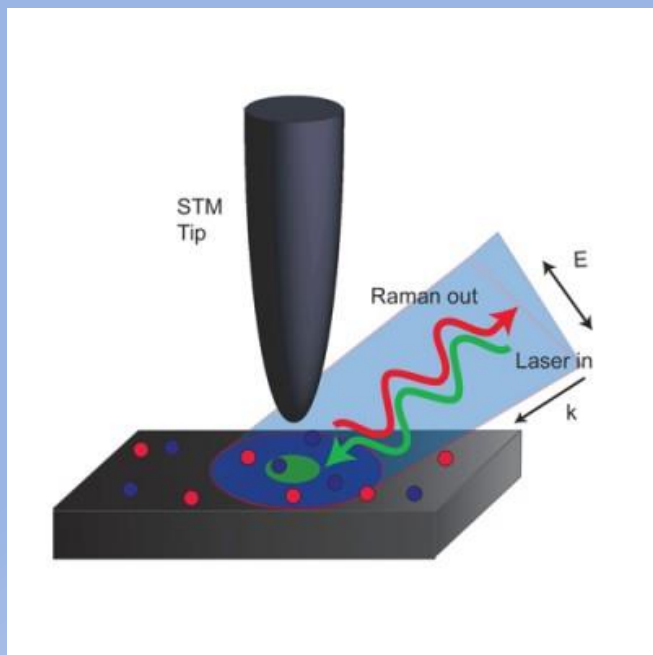
Electromagnetic enhancement (up to 10^{10})



Chemical enhancement/charge transfer (up to 10^3)

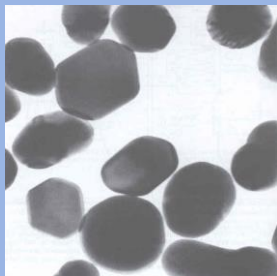


single molecule detection

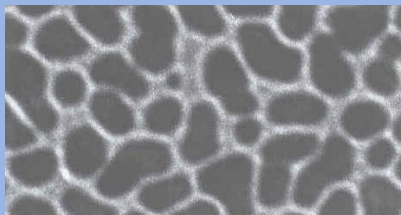


SERS active systems

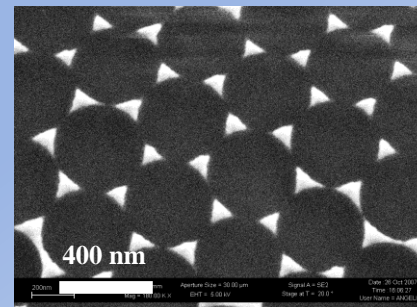
Colloidal metal nanoparticles



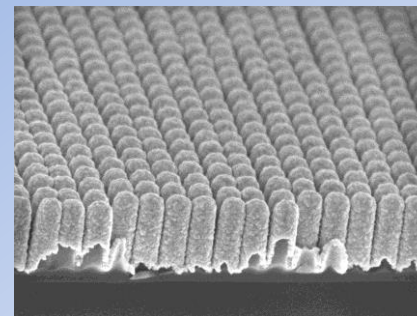
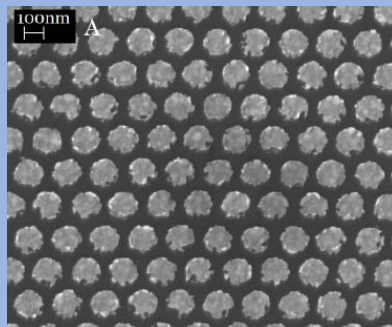
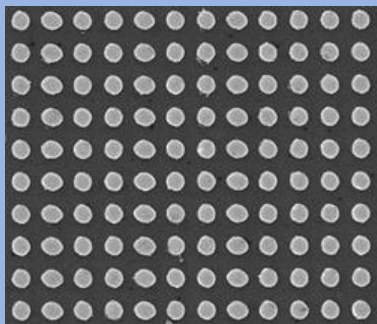
Island films



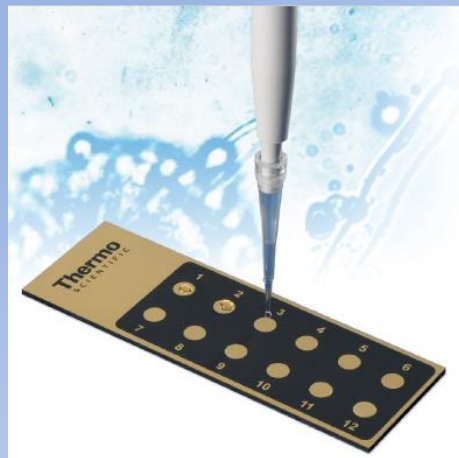
Periodic pattern by self-assembling: nanosphere lithography



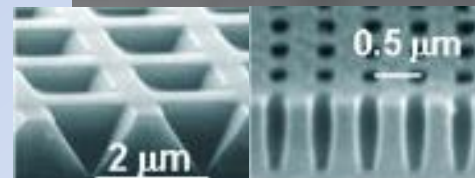
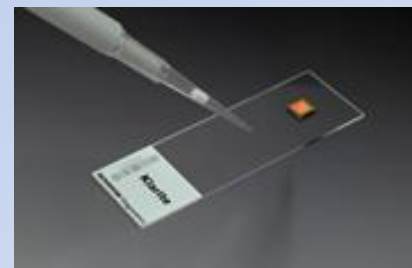
2D and 3D periodic nanostructures by photo/e-beam lithography



Thermo Scientific
SERS Analysis Package

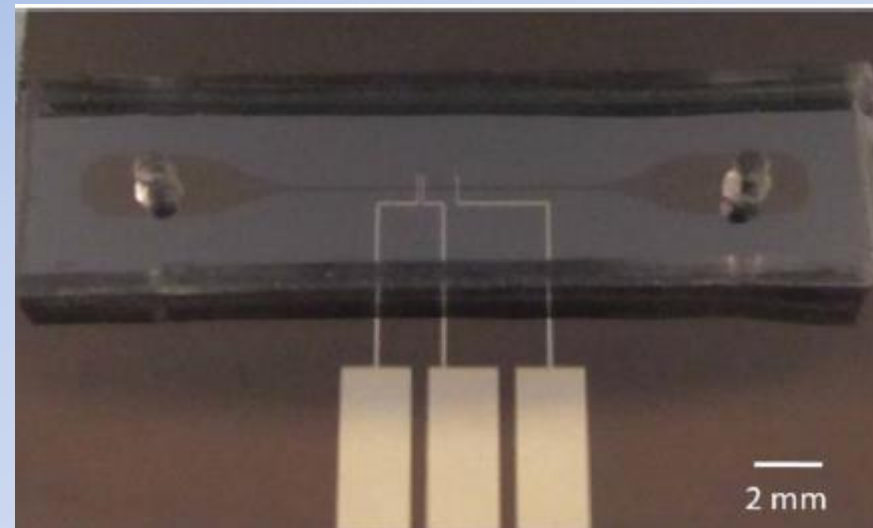
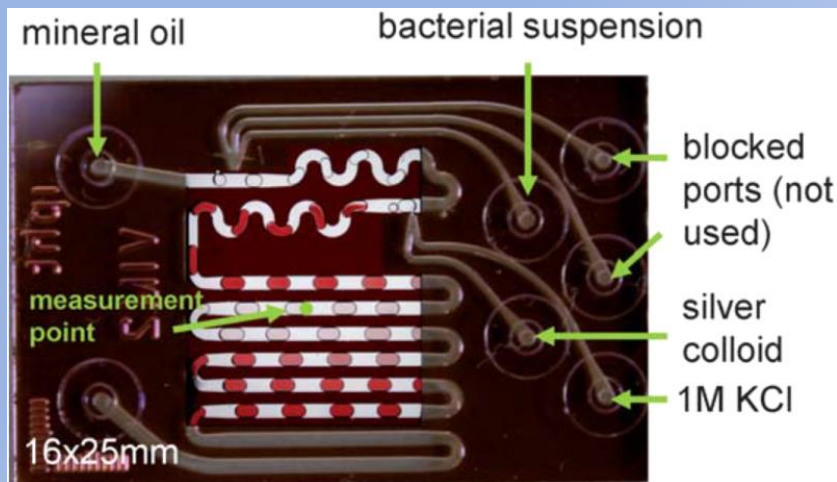
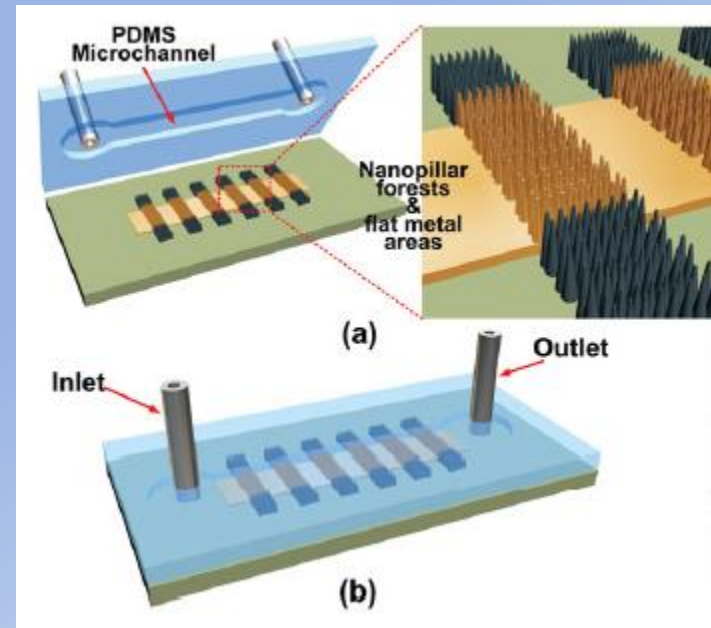


Klarite® SERS substrates
Renishaw



Raman spectroscopy & microfluidics

- Small amount of samples confined within microscale channels
- Improved uniformity of molecular distributions
- Highly precise controlled manipulation of biological samples



European projects on bio-Raman



PRIOSERS



Project reference: 623527

Funded under: [FP7-PEOPLE](#)

Prion Detection Through Organized Arrays of Gold Nanorods as SERS Substrates



VIBRA



Project reference: 648615

Funded under: [H2020-EU.1.1. - EXCELLENT SCIENCE - European Research Council \(ERC\)](#)

Very fast Imaging by Broadband coherent Raman



Nanoantenna



Project reference: 241818

Funded under: [FP7-HEALTH](#)

Development of a high sensitive and specific nanobiosensor based on surface enhanced vibrational spectroscopy dedicated to the in vitro proteins detection and disease diagnosis



Cross-SERS



Project reference: 329131

Funded under: [FP7-PEOPLE](#)

SERS ultrasensitive universal sensing of proteins through cross-reactive sensor arrays

European projects on bio-Raman




SAVVY 

Project reference: 310445

Funded under: [FP7-NMP](#)

Self-assembled virus-like vectors for stem cell phenotyping



Raman 

Project reference: 332462

Funded under: [FP7-PEOPLE](#)

Gold Nanoprisms as Raman Signal Amplifiers for Bioimaging of Lung Cancer

HORIZON
2020

ADiRaS 

Project reference: 683708

Funded under: [H2020-EU.2.3.1. - Mainstreaming SME support, especially through a dedicated instrument](#)
[H2020-EU.3.1. - SOCIETAL CHALLENGES - Health, demographic change and well-being](#)

Alzheimer's Disease Diagnosis by Spectroscopy. Accurate and Non-Invasive Medical Device for the Diagnosis of Early Stage Alzheimer's Disease.



cost
EUROPEAN COOPERATION
IN SCIENCE AND TECHNOLOGY

Agenda

9.15 Introduction

Fabrizio Giorgis – Politecnico di Torino

9.25 Surface-enhanced Raman spectroscopy of biofluids: from nano-bio interactions to clinical applications

Alois BONIFACIO – Dipartimento di Ingegneria e Architettura, Università di Trieste

9.45 Metal-dielectric nanostructures for on-chip Surface Enhanced Raman Scattering based biomolecular detection

Chiara NOVARA, Dipartimento di Scienza Applicata e Tecnologia, Politecnico di Torino

10.05 Raman spectroscopic imaging of tissues for possible clinical translation

Massimiliano ROCCHIA, *Thermo Fisher Scientific*

10.25 The road map towards providing a robust Raman spectroscopy-based cancer diagnostic platform and integration into clinic

Riccardo TAGLIAPIETRA, Renishaw