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Chemical study of illuminated manuscripts: a non invasive approach

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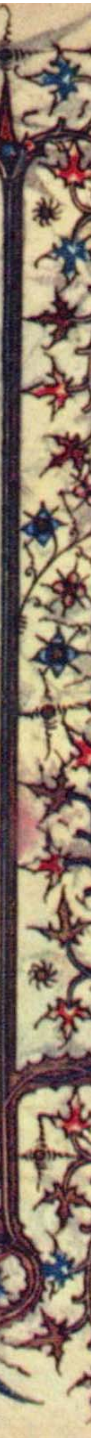


Background

Behind the text and images, an illuminated manuscript contains lots of hidden information related to the artist's work method and materials

Investigation of manuscripts should include the analysis of the entire surface without damages, guaranteeing the integrity of painted surface.

Over the past decades, advantage in technology contributed to developed non-invasive techniques that are nowadays successfully employed in the analysis of manuscripts



Objects of interest

XIII –XIV sec. Illuminated manuscripts belonging to *Gunnlibrary*



Medieval manuscript, with courtesy of Gunnerus Library

Aim of the project

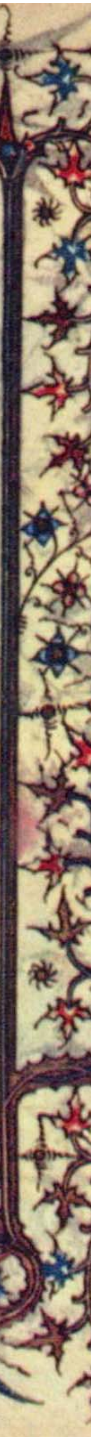
- Identification of pigments and binders
- Artist's techniques
- Identification of past cleaning and retouching processes
- State of conservation



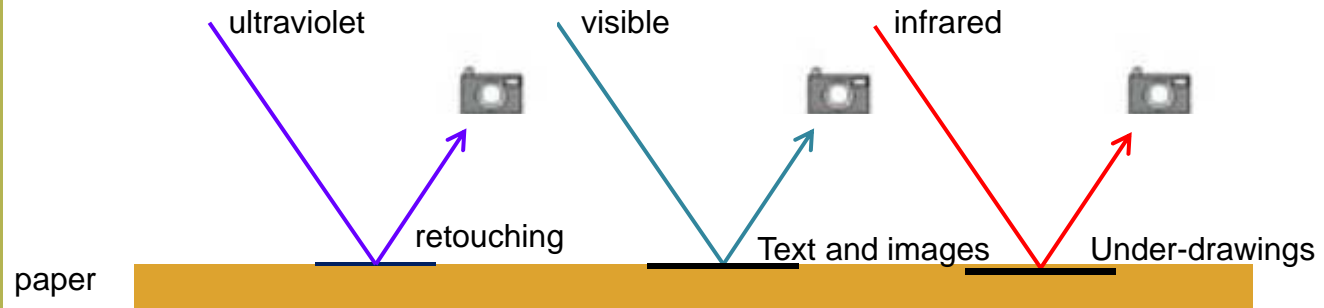
Techniques

For this aim, a multianalytical approach based on following techniques:

- Image analysis
 - Multispectral Imaging
 - Hyperspectral Imaging combined with multivariate data analysis
- X-ray Fluorescence Spectrometry (XRF)
- Near Infrared Spectroscopy (NIR)
- μ Raman spectroscopy
- Micro Fourier Transform Infrared spectroscopy (μ FTIR)



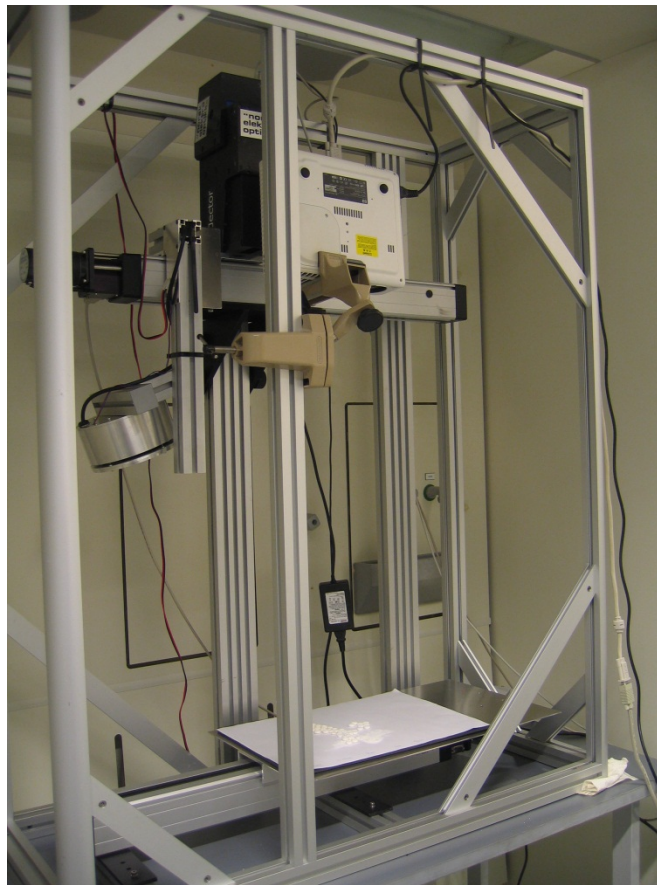
Multispectral Imaging [1]



Multispectral Imaging represents an important technique for the analysis of ancient manuscripts. Using a broad spectral range of analysis from UV to Infrared, including also visible light, it is possible to acquire through images information not perceptible by the human eye:

- retouching process
- damaging caused by age
- Under-drawings
- Ink ageing

Hyperspectral Imaging



Hyperspectral Imaging, with courtesy of Prof. Bjørn K. Alsberg

NIR Hyperspectral imaging technique refers to the acquisition of a series of digital images in the near infrared spectral region (900 – 1300 nm).

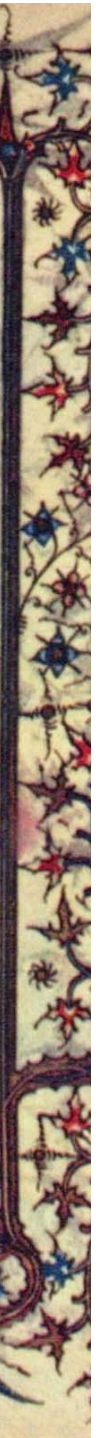
The result is an hyperspectral data cube, which contains one spectral reflectance image for each wavelength band.^[2]

Combined with multivariate approach, this technique can be used to obtain chemical images of the species of interest (i.e. distribution of a particular pigment)

Near IR

Recent studies has shown the possibility to detect characteristic vibrational overtone bands from paint binders at wavelength < 2500 nm.^[3]

For this reason, near infrared spectroscopy coupled with fiber optic probe can be used as non-invasive technique to detect binding-media in ancient manuscripts.



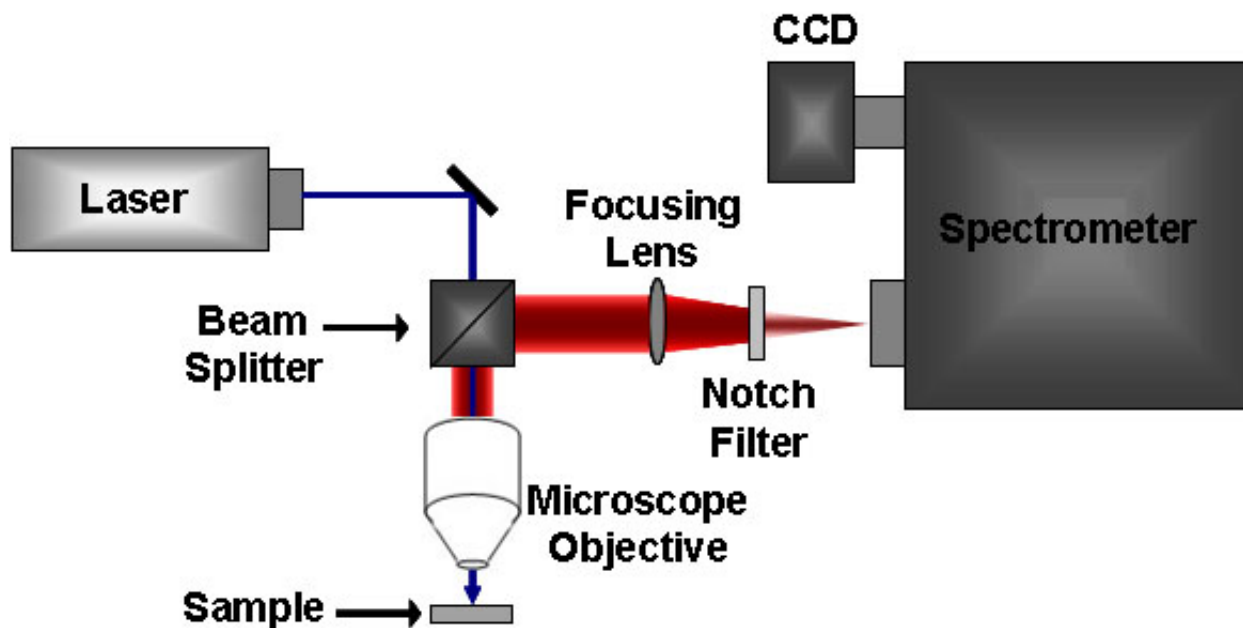
X-ray Fluorescence



X-ray fluorescence is a well-established non destructive technique for elemental analysis.

Key elements can be correlated to the pigment used in illuminate miniatures [4]

μ Raman

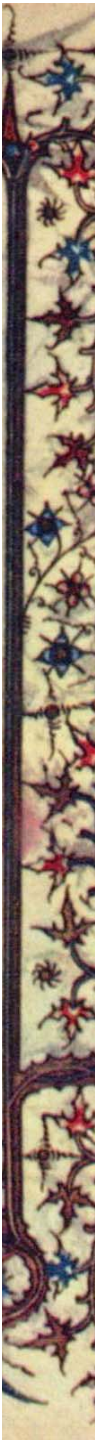


Payne, C., & Barron, A. 2010 *Surface-Enhanced Raman Spectroscopy for the Study of Surface Chemistry*. *Connexions*, June 5, 2010. <http://cnx.org/content/m34522/1.1/>.

Raman microscopy has been used for studying and identifying inorganic materials. Applied on illuminated manuscripts, Raman microscopy will be focused on pigment characterization.^[4]

μ FTIR

Although information obtained by raman spectroscopy is similar to that obtained by infrared spectroscopy, it is not identical. Infrared microscopy is able to provide information of organic and inorganic material used by an artist.^[4]



Bibliography

- [1] Lettner M and Sablatnig R, *Multispectral Imaging for Analyzing Ancient Manuscripts*, 17th European Signal Processing Conference (EUSIPCO 2009), Glasgow, Scotland, August 24-28, 2009
- [2] Padoan R et al, *Quantitative Hyperspectral Imaging of Historical Documents: Technique and Applications*, 9th International Conference on NDT of Art, Jerusalem Israel, 25-30 May 2008
- [3] Vagnini M et al, *FT-NIR spectroscopy for non-invasive Identification of natural polymers and resins in easel paintings*, (2009) *Anal Bioanal Chem* 395:2107–2118
- [4] Pessanha S, *Application of spectroscopic techniques to the study of illuminated manuscripts: A survey*, (2012) *Spectrochimica Acta Part B* 71-72:54-61

