

XINXIANG BAIHE O.E CO.,LTD

Zhang Jiamin, Zhang Bo
XINXIANG BAIHE O.E CO.,LTD
XINXIANG NEW-HI-TECH ZONE WEST, China
E-mail: xxbh_zjm@vip.163.com
<http://www.baiheoe.com>

XINXIANG BAIHE O.E CO.,LTD is a professional processing enterprise with vacuum coating technology. Our core team has more than 30 years of experience of both coating technology development and volume production.

We have 12 sets of high configuration vacuum coating machines with different size of 1.8m, 1.3m, 1.1m, 1m and 800mm. All of our machines are equipped with two electron beams, and most of them are also equipped with ion source and polycold. We also have two sets of ultrasonic wave cleaners and three spectrophotometers. Our main plant covers an area of 15,000 square meters with 1,000-square-meter ultra-clean workshop.

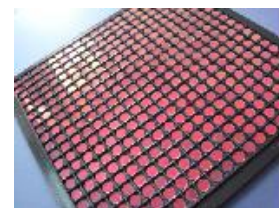
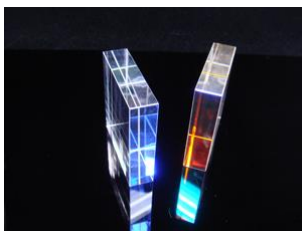
Our main products include Broadband Anti-Reflection Coating, High-Reflection Coating (Metallic film, Dielectric film), Beamsplitters, ITO, Interference Filter (Long-pass, Short-pass, IR-cut), Bandpass Filer (Wide bandpass, Narrow bandpass), Polarizing Coating, Anti-Polarizing Coating, Narrow-band Reflection Filter, Laser Coating, and Color Temperature Adjusting Film.

Regarding to our good reputation and technology advantages for many years, we have been providing our services and products to many multinational companies around the world, such as Epson and Panasonic.

Xinxiang Baihe O.E. was established in 2004 with ISO 9001:2000 Quality of Management System Certification and ISO 14001:2004 Environment Management System. Our company is located in Xinxiang City, in Henan Province, whose transportation is very convenient, because Beijing-Guangzhou Railway and the Beijing Hong Kong and Macao highway passes through this city.

Our products:

- IPL Filters;
- Components of Exposure Machine;
- Optical windows;
- Broadband Anti-Reflection Coating;
- High-Reflection coating;
- Interference filters.



Recent Advances in 3D imaging & Spectroscopy

Er-Jun Liang

Institute of Photonics and Optoelectronics,
Zhengzhou University

E-mail: ejliang@zzu.edu.cn

2013.12.12

Outlines

- I. Light field Imaging & Gigapixel camera
- II. Fresnel Incoherent Correlation Holography
- III. Lens-free Holography
- IV. Chemical Selective Holography
- V. Coded Aperture Spectroscopy
- IV. Research Orientations in Optics in Zhengzhou University

Advancements in Imaging Technology

In recent years, 3D imaging has made impressive progress both in theories and technology , including

- Compressive sensing (CS) theory (2006-)
- Ray tracing & digital refocusing (Light field camera 1.0 and Light field camera 2.0)
- Gigapixel imaging and camera
- Fresnel Incoherent correlation holography (FINCH)
- On-chip Lens-free holography
- Coherent anti-stokes Raman scattering holography
- single pixel imaging

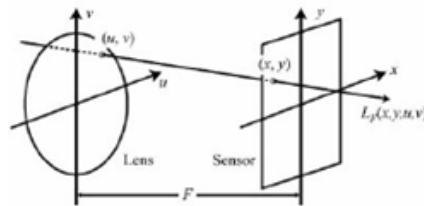
.....

I. Light field Imaging & Gigapixel camera

Plenoptic Function of Light Field

A light field can be described by $L(\theta, \phi, \lambda, t, x, y, z)$ with 7 parameters.

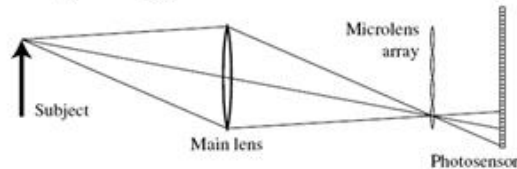
● For 3D imaging, using 4 parameters being enough to trace any light ray $L(x, y; u, v)$ — 4D light field.



● A 4D light field contains 3D information of the world. In principle, by ray tracing, one can obtain information from any point of the field on one exposure with a light field camera.

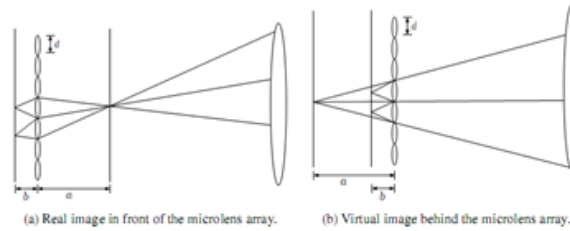
Light field camera 1.0

● A microlens array is placed at the focus plane of the imaging main lens. By digital refocusing (back propagation), one can get a well refocused image of any plane of the field from one exposure.



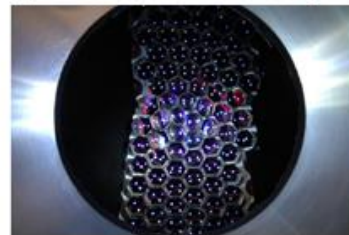
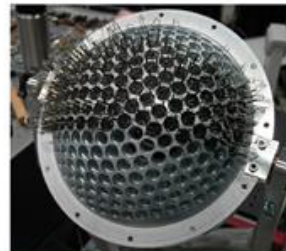
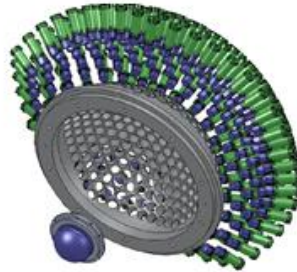
Light field camera 2.0 —Plenoptic camera

- A microlens array is inserted between the main lens and the sensor (CCD/CMOS), but not at the focus plane of the main lens.



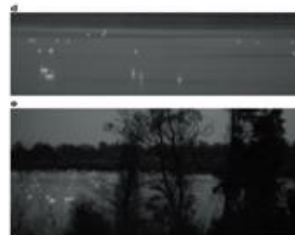
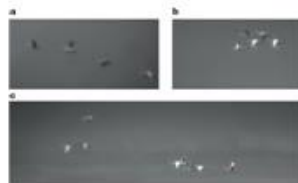
- Advantages: Higher resolution, 3D display
- Disadvantages of the present light field camera: low resolution, field depth and resolution needs to be improved.

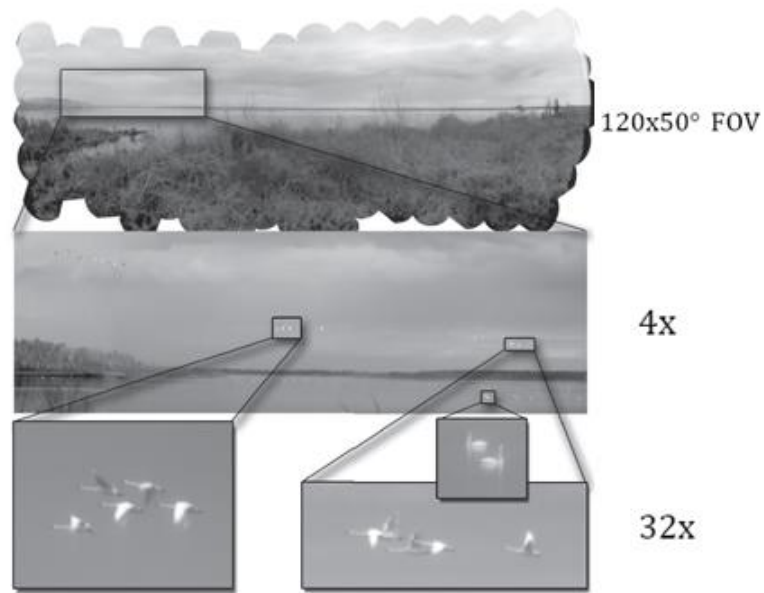
Multiscale gigapixel photography



- High resolution
- Large field of view (FOV)
- Large depth of field

D. J. Brady et al. Nature, 486, 388(2012)

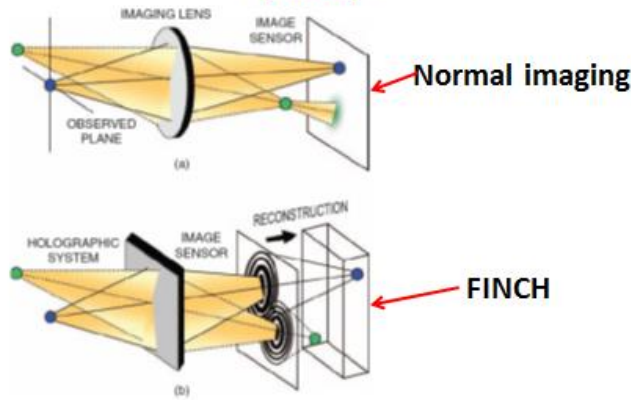




II. Fresnel Incoherent Correlation Holography (FINCH)

FINCH systems have been developed based on the principle of interference using an incoherent light source. The EM wave from a point object is divided into a plane wave and a spherical wave and then interference at the sensor plane. FINCH systems such as FINCH microscope, FINCH-camera have appeared.

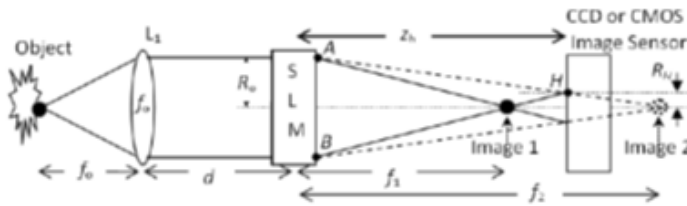
Fresnel incoherent correlation holography (FINCH)



Fresnel incoherent correlation holography (FINCH)

● **Principle:**

Interference of plane and spherical beams from objects.



SLM — space light modulator

Applications : holographic microscopy , Bio-medical imaging, etc.

Problem: 3 exposures are needed to eliminate the self correlation terms and the twin image.

Theory

❖ **Hologram of a 3D object $g(x_s, y_s, z_s)$:**

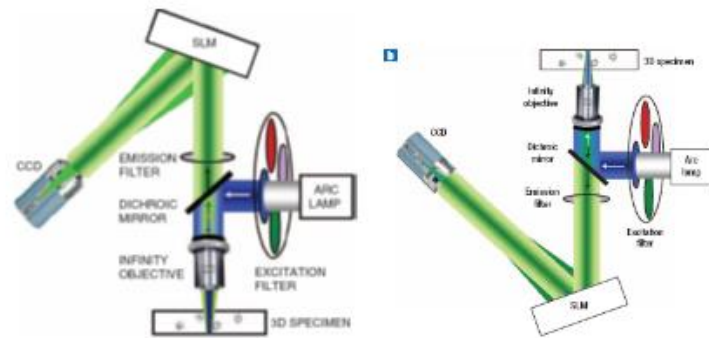
$$\begin{aligned}
 H(x, y) &\cong A \left(C + \iiint g(x_s, y_s, z_s) \exp \left\{ \frac{i\pi}{\lambda\gamma(z)} \left[\left(x + \frac{ax_s}{f} \right)^2 + \left(y + \frac{ay_s}{f} \right)^2 \right] + i\theta \right\} dx_s dy_s dz_s \right. \\
 &\quad \left. + \iiint g(x_s, y_s, z_s) \exp \left\{ \frac{-i\pi}{\lambda\gamma(z)} \left[\left(x + \frac{ax_s}{f} \right)^2 + \left(y + \frac{ay_s}{f} \right)^2 \right] - i\theta \right\} dx_s dy_s dz_s \right)
 \end{aligned}$$

Twin images

❖ **Reconstructed image:**

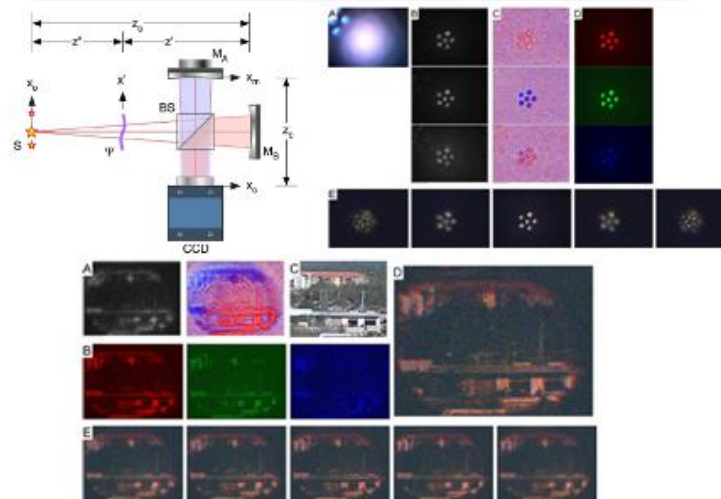
$$s(x, y, z) = H_F(x, y) * \exp \left[\frac{i\pi}{\lambda z} (x^2 + y^2) \right]$$

FINCH-microscope



In order to overcome the 3 times exposure, Fourier-FINCH system has also appeared.

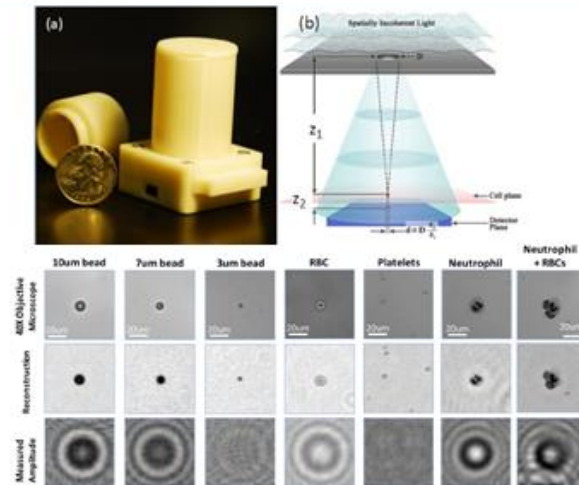
Full color natural light holographic camera



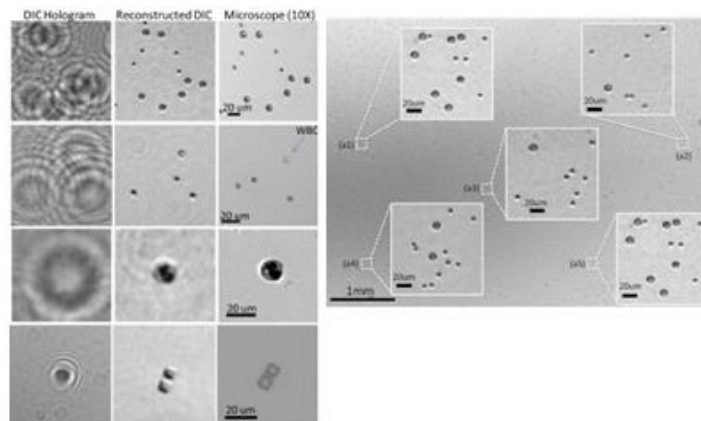
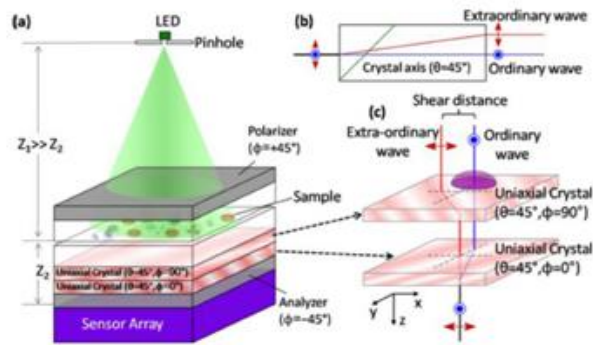
III. Lens-free Holography

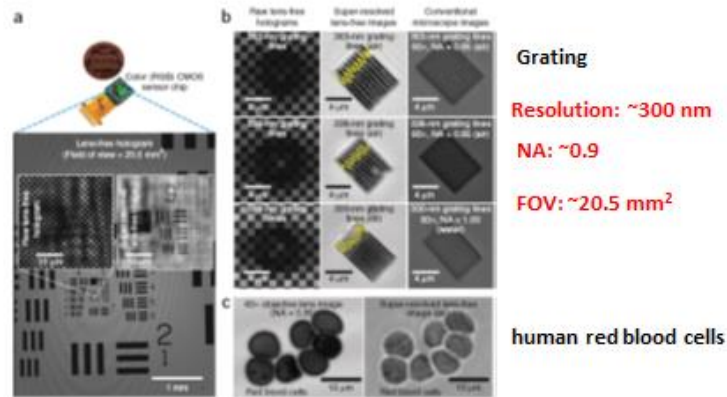
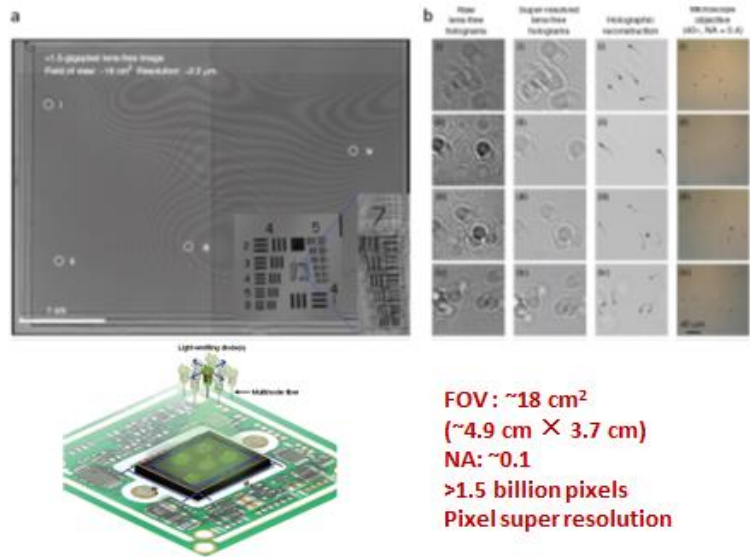
- Simple imaging system
- Large field of view
- 3D imaging
- Super resolution

On-chip Lens-free holography



On-chip Lens-free holography

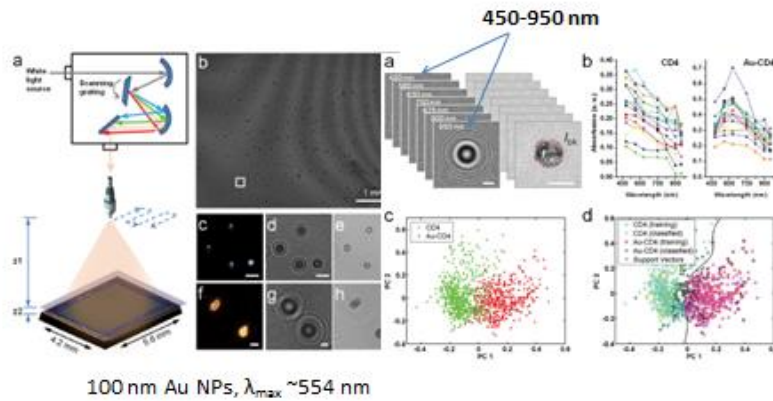




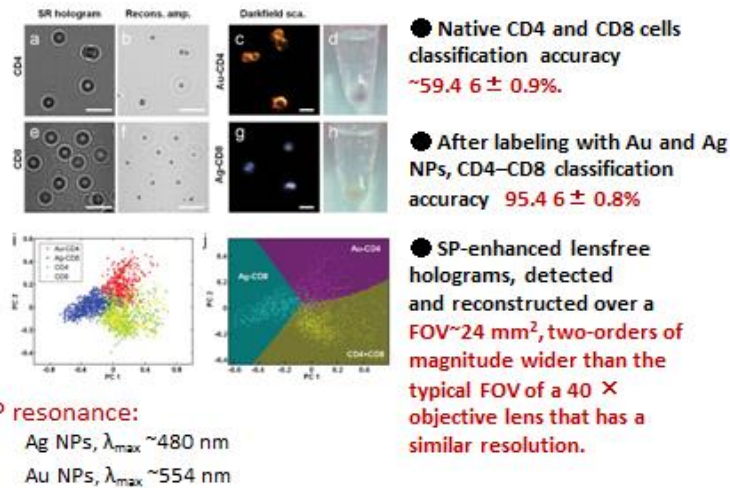
IV. Chemical Selective Holography

- Besides the shapes, discrimination of chemical compositions is also important. Here we introduce two:
 - › Surface Plasmon enhanced lens-free holography
 - › Coherent anti-Stokes Raman scattering Holography

1. Surface Plasmon Enhanced Lensfree Holography – Based on different resonant wavelengths of metal particles



Qingshan Wei, et al. SCIENTIFIC REPORTS, 3 : 1699(2013)



2. Coherent anti-Stokes Raman scattering (CARS) holography

CARS:

$$I_{as}(z) \propto |\chi^{(3)}|^2 I_p^2 I_s z^2 \left(\frac{\sin(\Delta k z/2)}{\Delta k z/2} \right)^2$$

Holography:

$$S = |S(x, y)| e^{j\phi(x, y)}$$

$$R = |R| e^{j2\pi(u_{Rx}x + v_{Ry}y)}$$

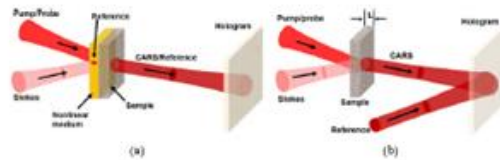
$$I(x, y) \propto ||R| e^{j2\pi(u_{Rx}x + v_{Ry}y)} + |S(x, y)| e^{j\phi(x, y)}|^2 = \text{d.c.} + (R^* S + RS^*)$$

CARS Holography

$$E(z, t) = A_p e^{j(\mathbf{k}_p \cdot \mathbf{r} - \omega_p t)} + A_s e^{j(\mathbf{k}_s \cdot \mathbf{r} - \omega_s t)} + c.c.$$

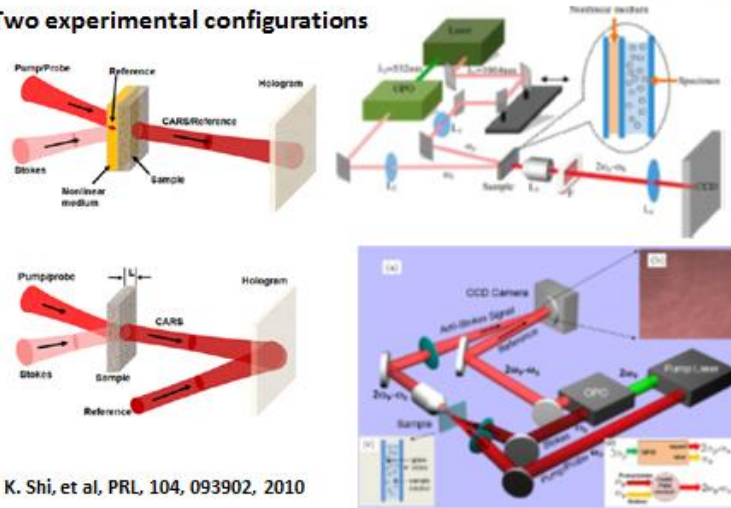
$$P^{NL}(\omega_{as}) = \epsilon_0 \chi^{(3)}(\omega_{as}) A_p^2 A_s^* e^{j(2\mathbf{k}_p - \mathbf{k}_s) \cdot \mathbf{r}}$$

$$\chi^{(3)}(\omega_{as}) = \frac{A_R}{\omega_r - (\omega_p - \omega_s) - j\gamma} + \chi_{NR}^{(3)}$$



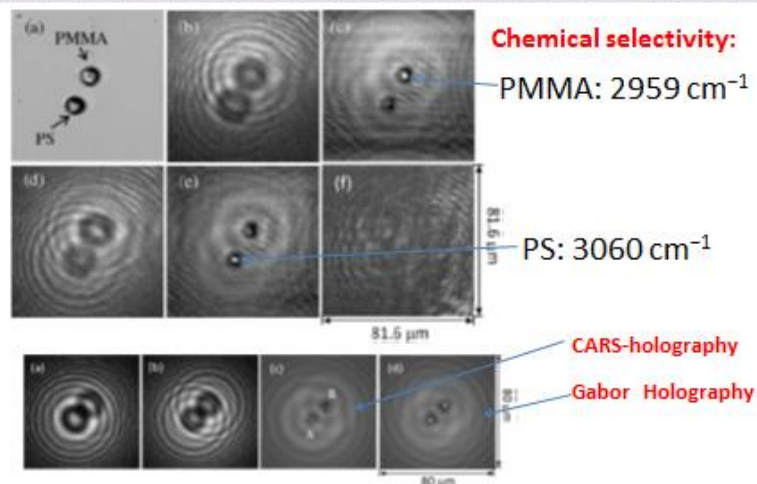
Coherent anti-Stokes Raman scattering (CARS) holography

Two experimental configurations



K. Shi, et al, PRL, 104, 093902, 2010

Coherent anti-Stokes Raman scattering (CARS) holography



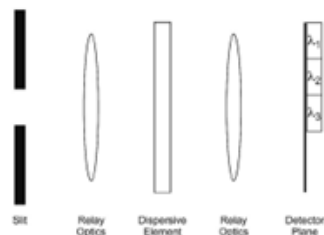
K. Shi, et al, PRL, 104, 093902, 2010

V. Coded Aperture Spectroscopy

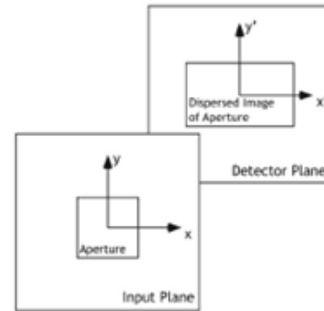
The difficulty in working with highly scattering samples: the source has a larger étendue than can be measured by traditional spectrometers.

Coded aperture spectroscopy

Traditional spectrograph



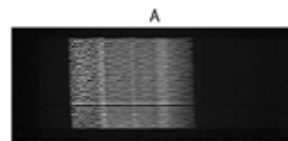
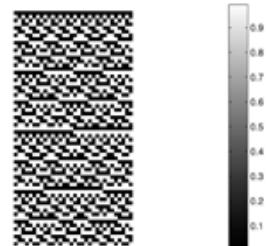
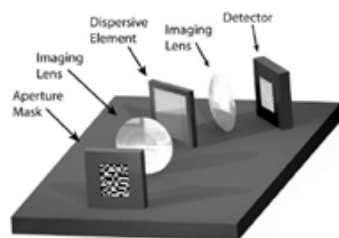
étendue
 $U = A \cdot \Omega = bh \cdot a^2 / f^2$
b —width of the slit,
h —height of the slit
a —limiting aperture



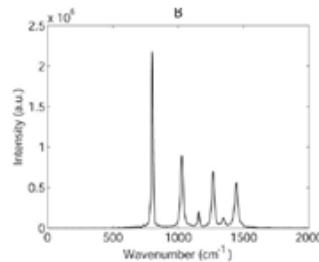
Coded aperture:

Replace the slit in the input aperture of a dispersive spectrograph by a 2D pattern of openings based on the Hadamard matrices.

Coded aperture Raman spectroscopy



CCD image of Raman spectrum of cyclohexane



Reconstructed Raman spectrum

VI. Research Orientations in Optics in Zhengzhou University

We are interested in the following research areas and now setting up laboratories for the researches. Related devices or apparatus are being purchased. Any suggestions or cooperation in these areas are welcome and highly acknowledged.

Research Orientations in Optics of Zhengzhou University

- **Imaging Physics and Devices**
3D imaging from Light field (Light field Camera)
Quantum imaging, Single pixel imaging
- **Digital Holography**
Fresnel incoherent correlation holography,
Fourier incoherent correlation holography,
Lens-free holography
- **Photonics and Spectroscopy**
Surface-plasmon enhanced imaging and spectroscopy (Chemical selective imaging),
Multi-spectral imaging and information fusion,
Spectroscopic technologies based on 3D imaging.
- **EM Information Transmission and Detection**
- **Laser Technology and Application**