IR Spectroscopy @ NSLS-2 and Physics of Strong Correlations

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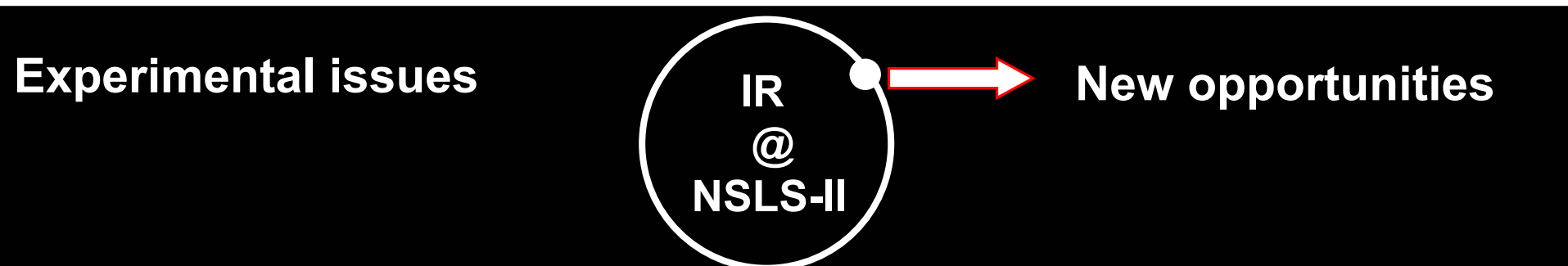
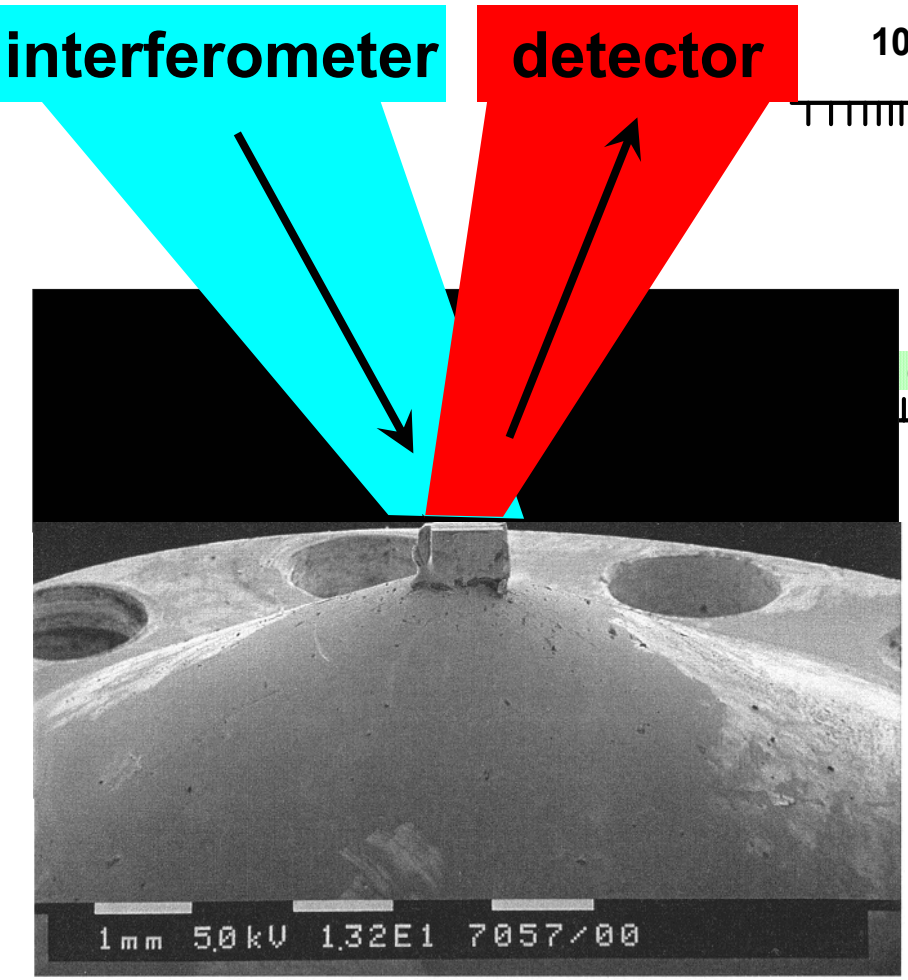
Doped Mott-Hubbard Insulators
- spectral weight transfer
- spin/charge inhomogeneities

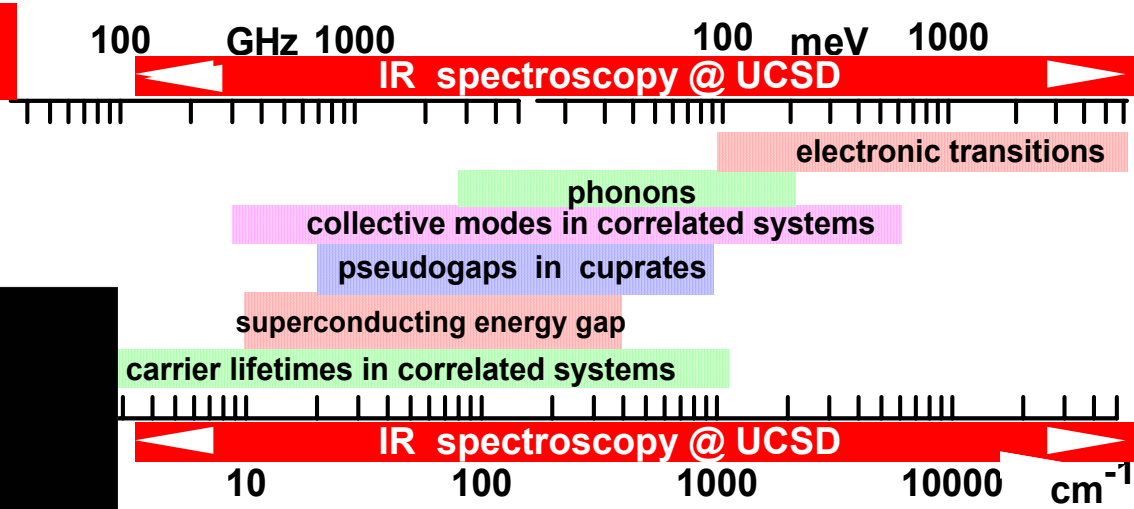
Magnetism
- inter-metallic ferromagnets
- ferromagnetic semiconductors
- optical control of magnetic state

High-Tc superconductors
- inhomogeneous condensate
- pairing "glue"
- energetics

FET structures
- magnetic
- organic fet

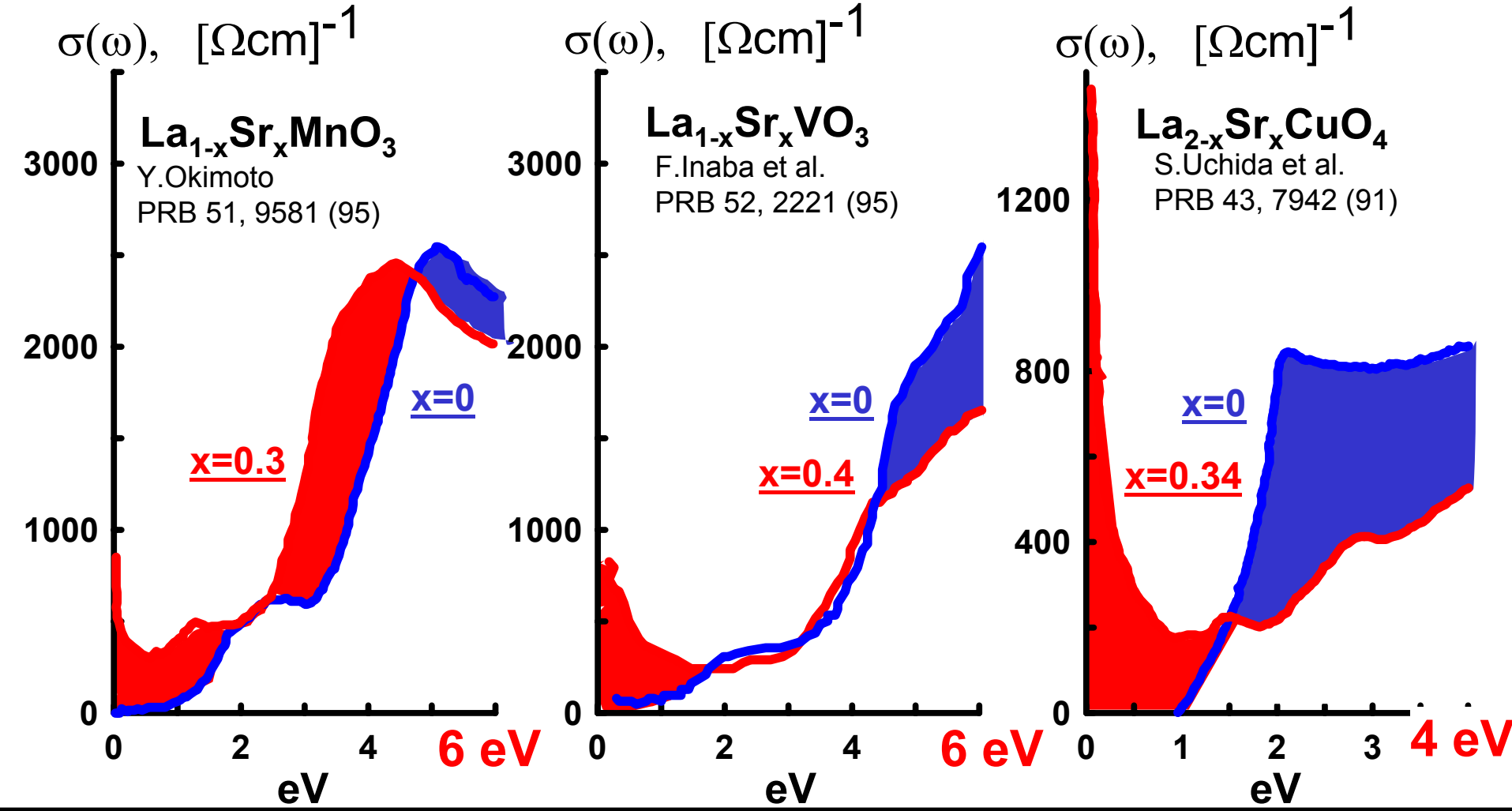






1. Broad spectral coverage
2. Optical constants: $\sigma_1(\omega) + i\sigma_2(\omega)$ and sum rules
3. Anisotropy
4. Large probing thickness
5. Micro-crystals

1. Doped Mott-Hubbard Insulators



Experimental issues:

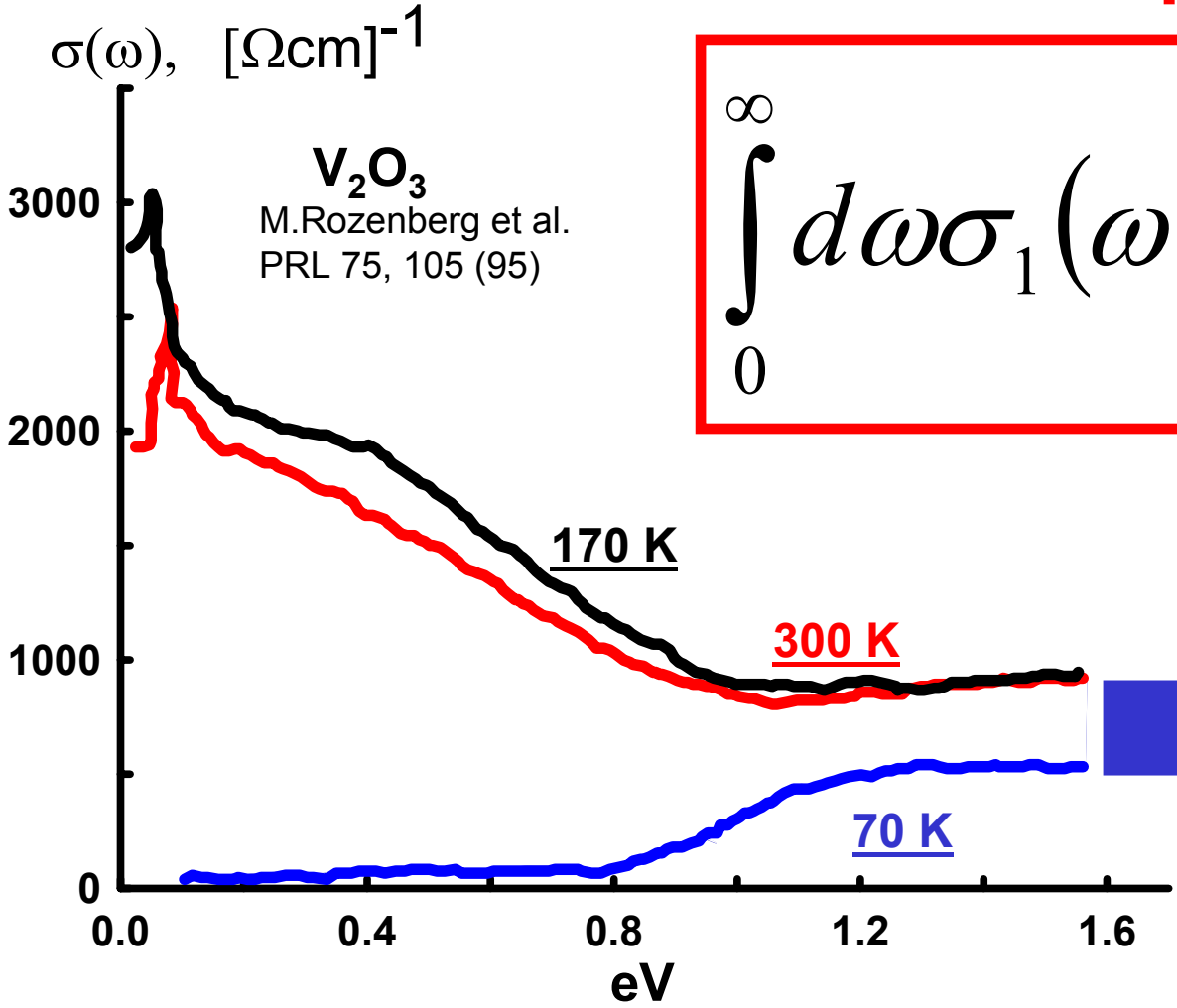
High-ω data is needed for KK analysis

IR @ NSLS-II

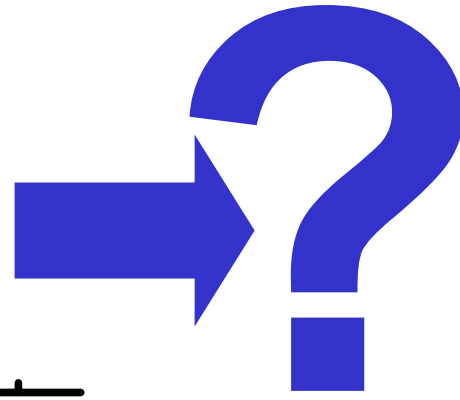
R(ω) data at ω < 36 eV

Beam-line based ellipsometry

2. Doped Mott-Hubbard Insulators: T dependence



$$\int_0^\infty d\omega \sigma_1(\omega) = \frac{n}{m_e}$$



Experimental issues:

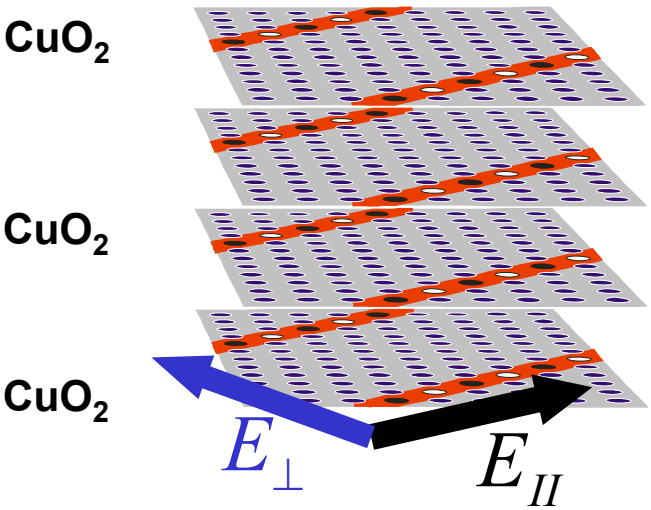
T, H dependence of σ(ω) over anomalously broad ω range

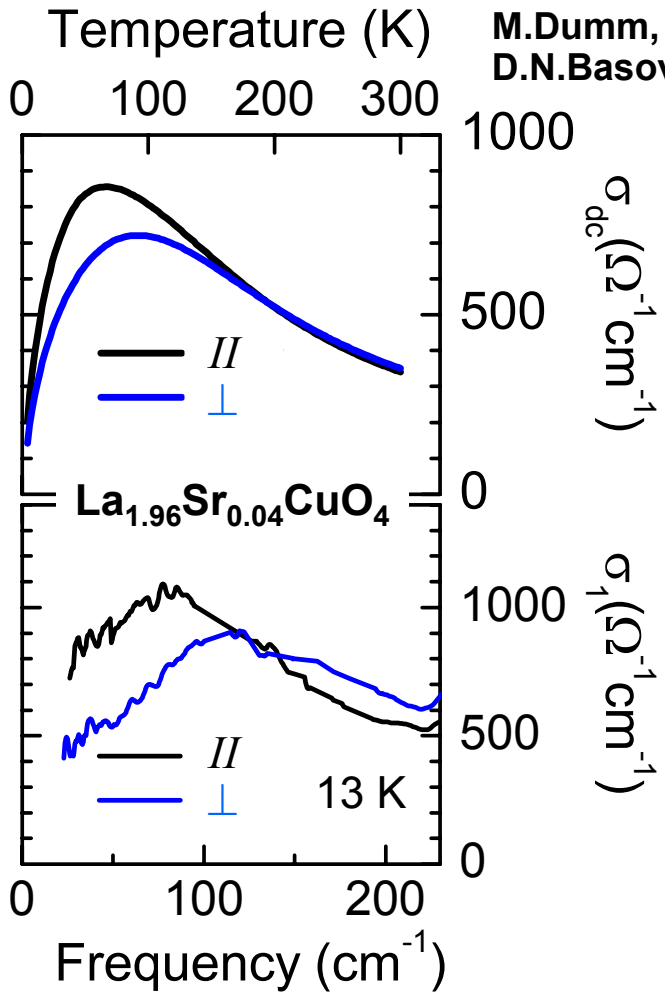
IR @ NSLS-II

Accurate data over broad ω intervals

Beam-line based ellipsometry

3. Doped M-H Insulators: charge inhomogeneities



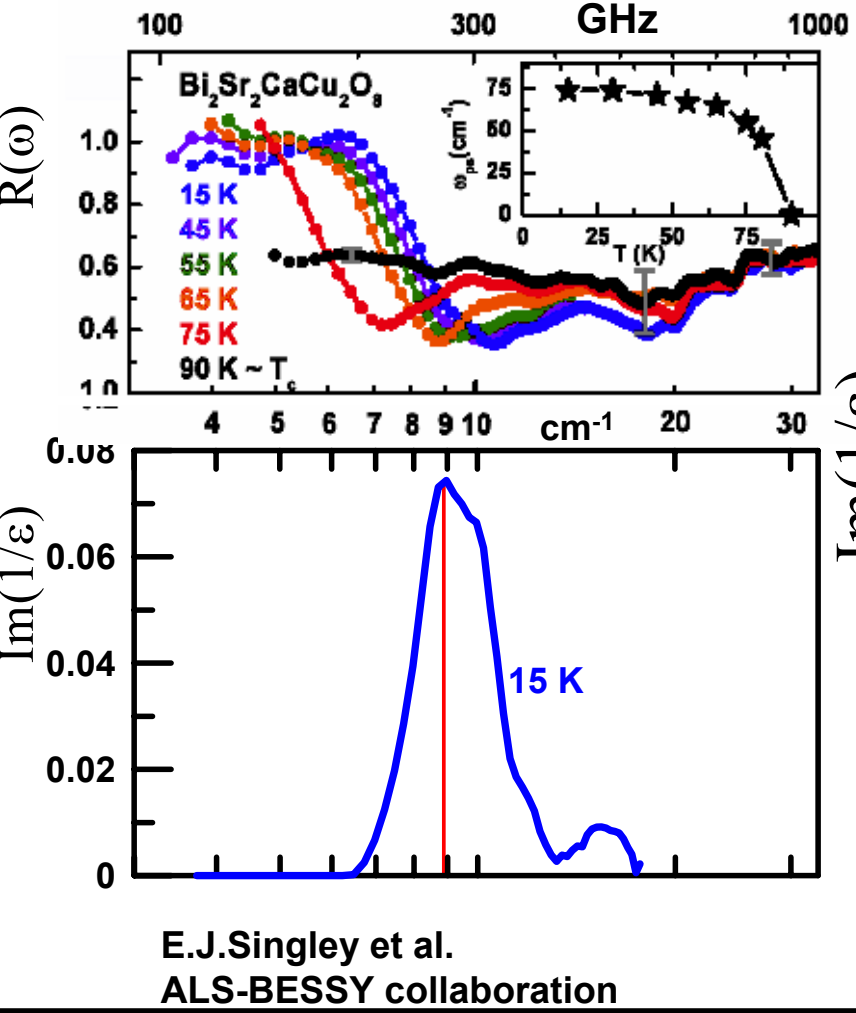


M.Dumm, S.Komiya, Y.Ando, D.N.Basov, PRL 91, 077004 (03).

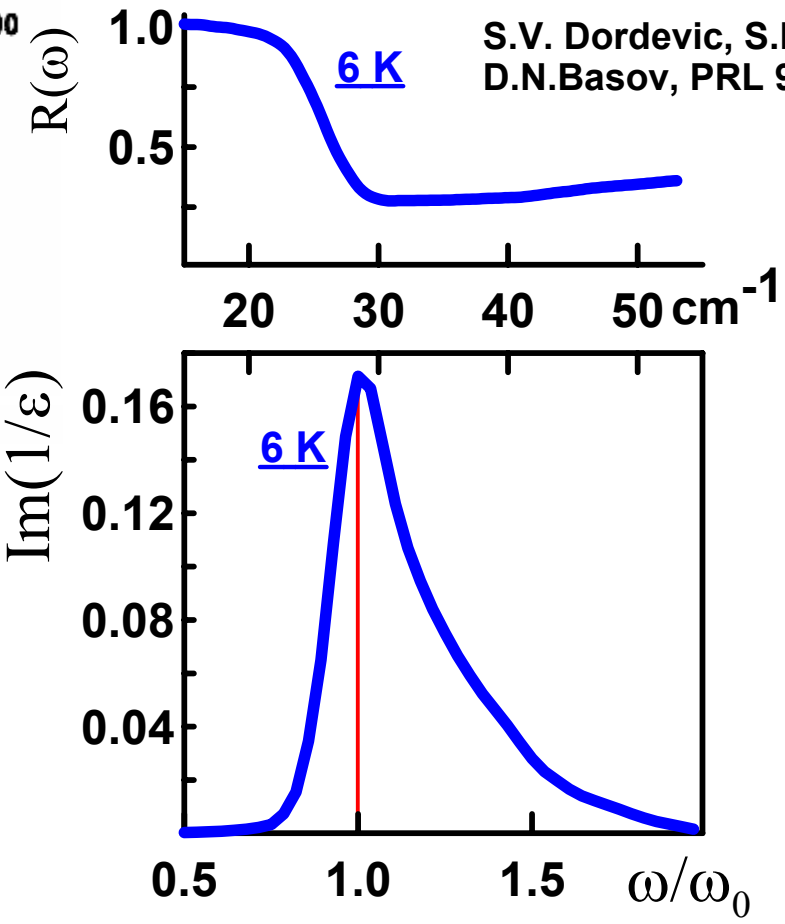
Experimental issues:
Micro-crystals

IR @ NSLS-II → **High intensity, Beam-line based IR microscopy**

4. Doped MH Insulators: inhomogeneous superconductivity



E.J.Singley et al.
ALS-BESSY collaboration



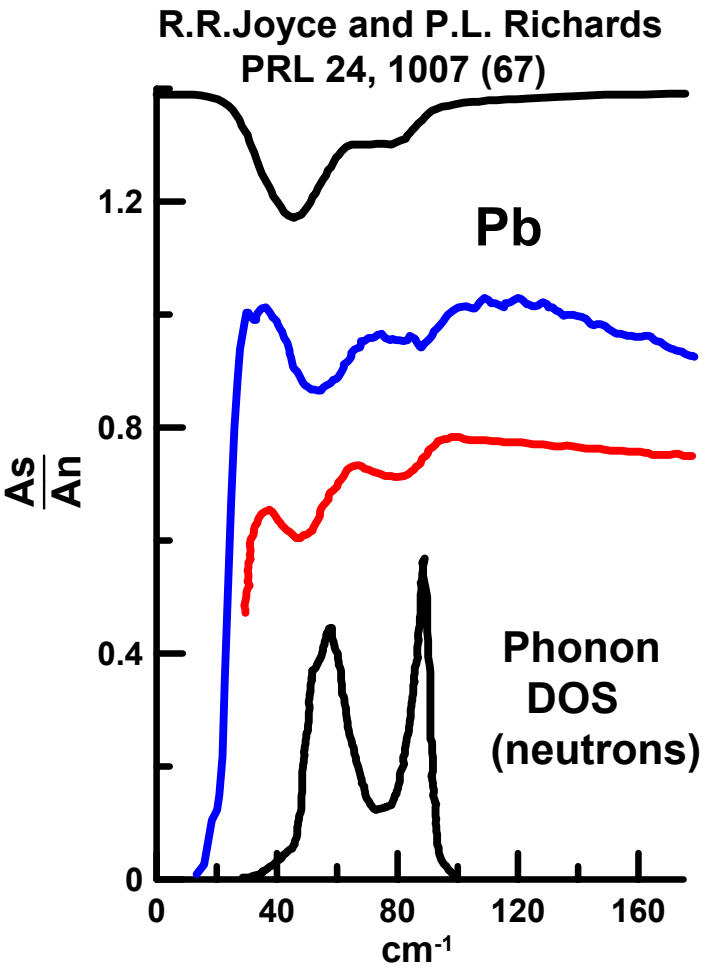
S.V. Dordevic, S.Komiya, Y.Ando, D.N.Basov, PRL 91, in press (03)

"Josephson plasmon microscopy"

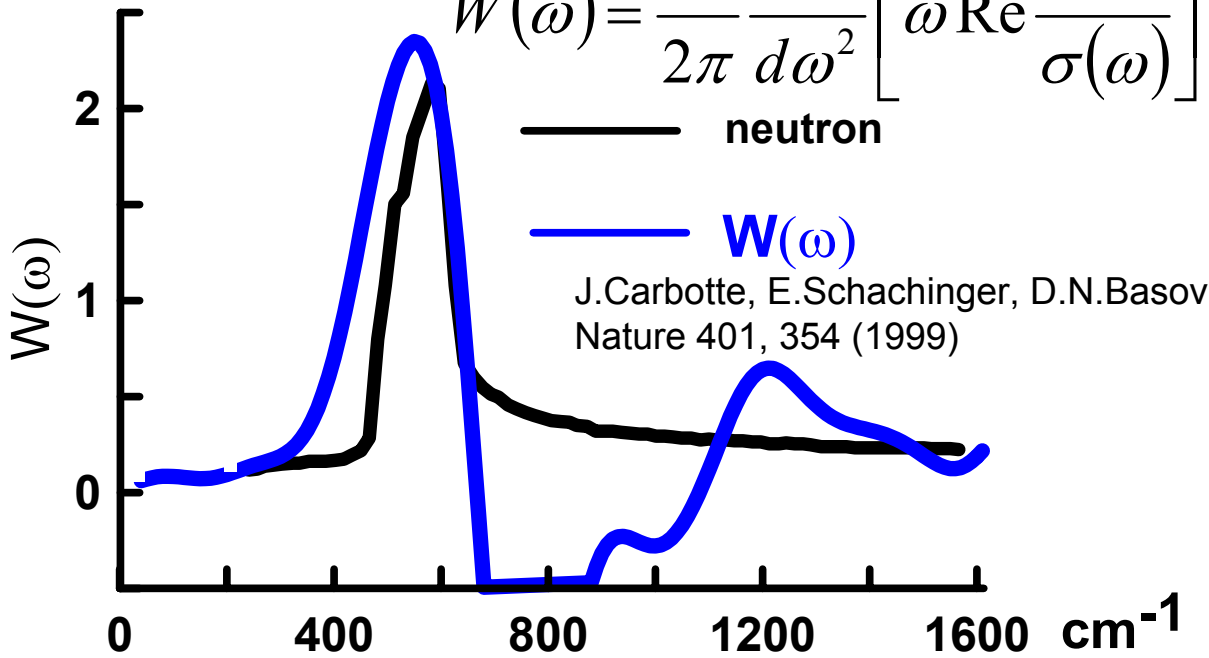
Experimental issues:
Sub-THz ω region

IR @ NSLS-II → "coherent" radiation

5. High-Tc superconductivity: pairing interaction



$$W(\omega) = \frac{1}{2\pi}\frac{d^2}{d\omega^2}\left[\omega \,\mathrm{Re}\frac{1}{\sigma(\omega)}\right]$$



Magnetic?

consistent with ARPES, tunneling,

Phonons? /A.Lanzara et al. Nature 412, 510 (2001)/

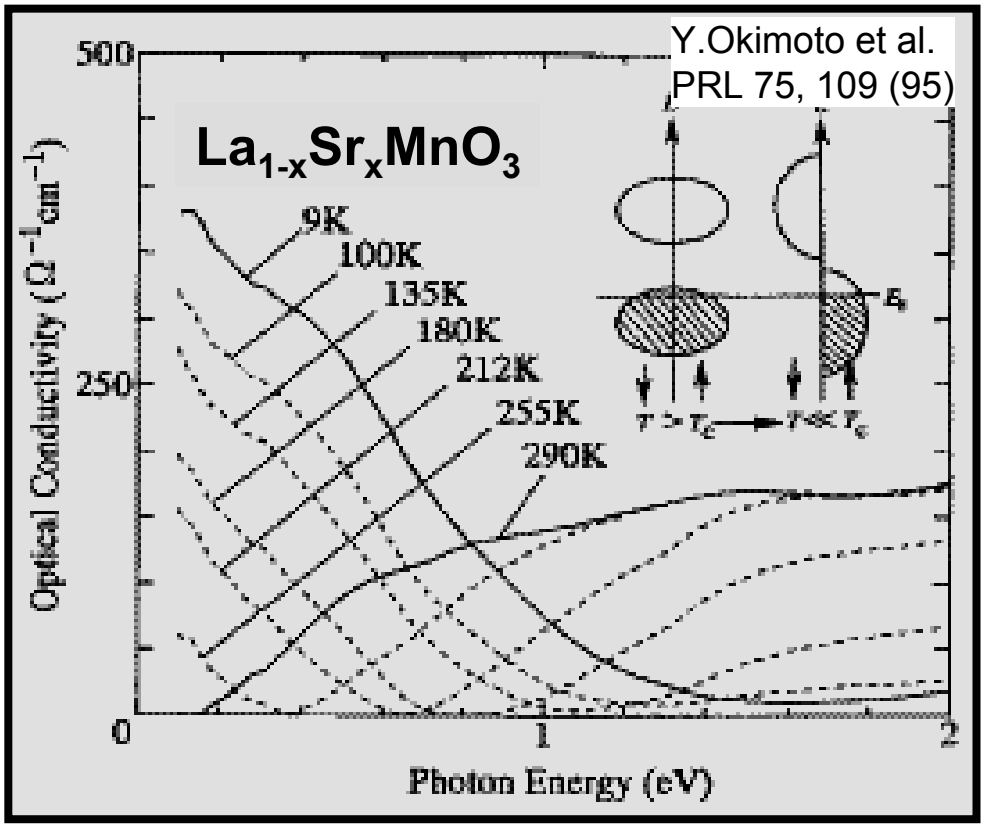
… but no isotope effect /N.Wang et al. PRL 89, 87003 (03)

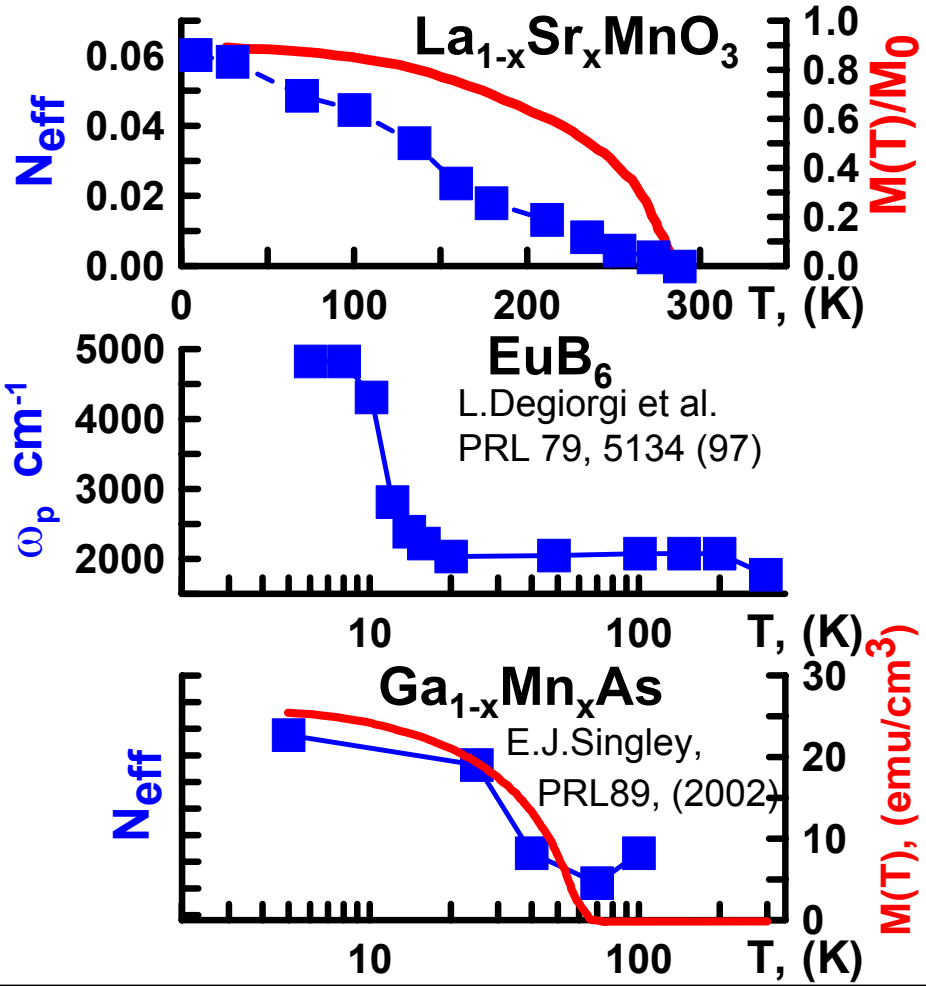
Experimental issues:

Second derivative of $1/\tau(\omega)$

IR @ NSLS-II → **Beamlines-based ellipsometry**

7. Magnetism: itinerant intermetallic ferromagnets





Experimental issues:

Bandwidth?

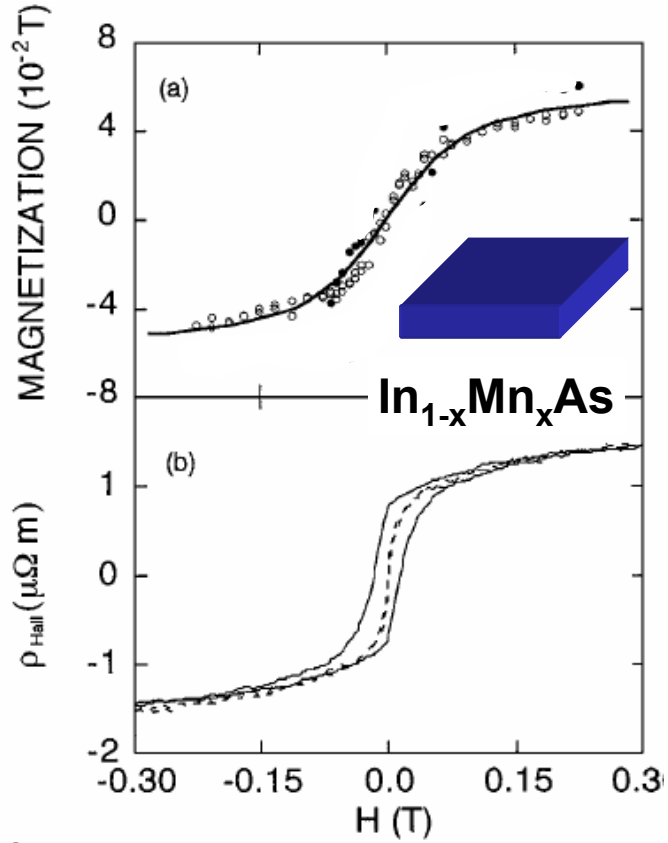
"Undressing" effect?

Sum rule violations

IR @ NSLS-II

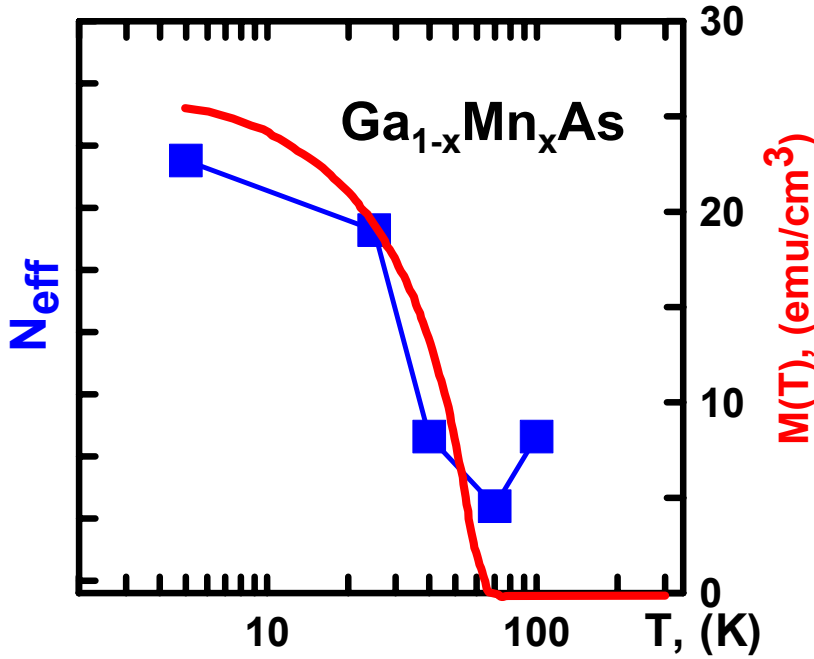
Beamline-based ellipsometry

8. Magnetism: ferromagnetic III-V semiconductors

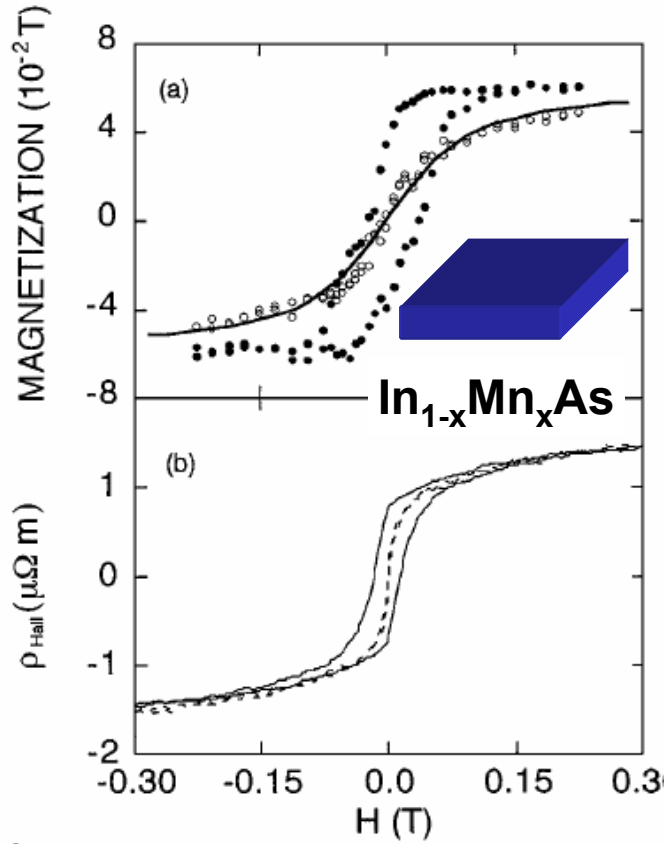


S.Koshihara et al. PRL78, 4617 (1997)

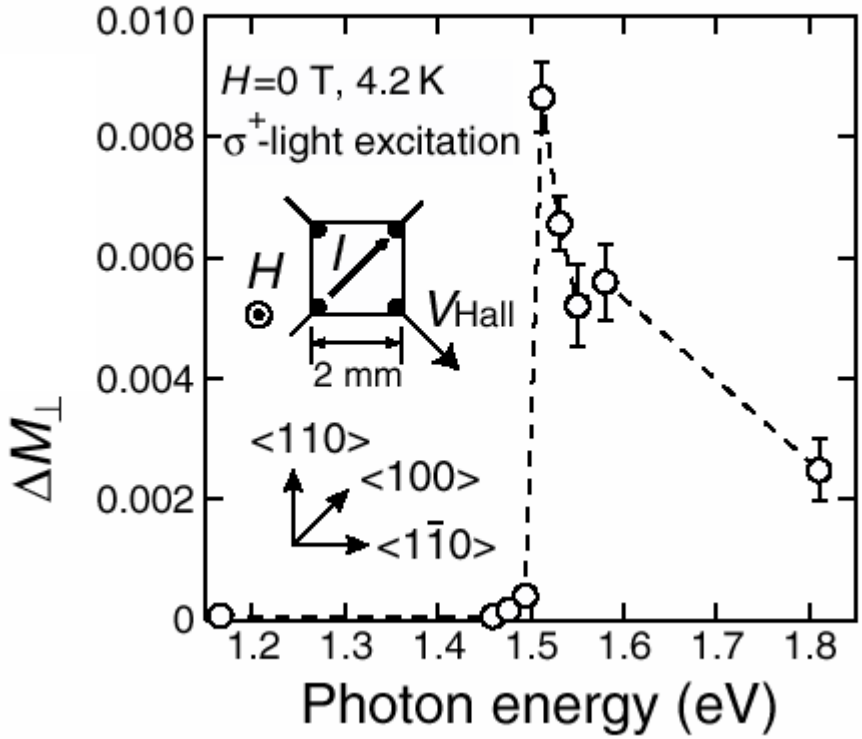
E.J.Singley, R.Kawakami, D.D.Awschalom, D.N.Basov, PRL89, 97203 (2002)



8. Magnetism: optical control of magnetic state



S.Koshihara et al. PRL78, 4617 (1997)

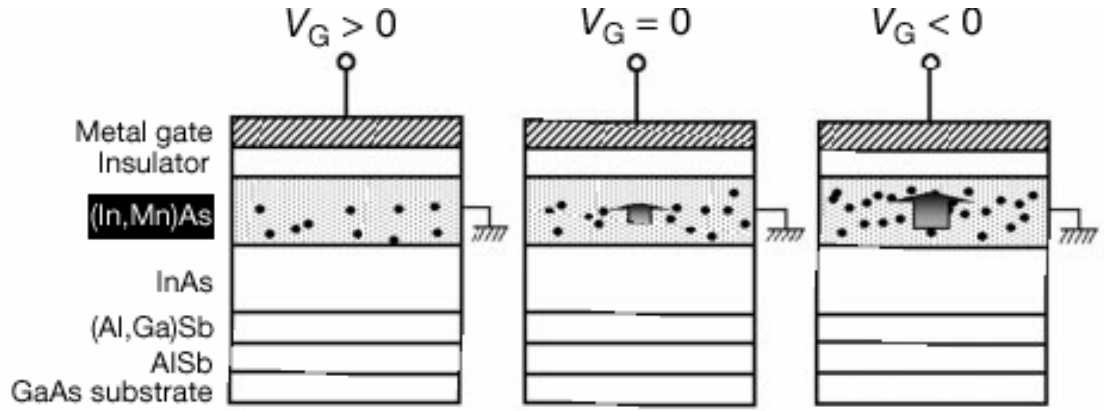


A.Oiwa, Y.Mitsumori, T.Slupinski, H.Munekata, PRL 88, 137202 (2002)

IR @ NSLS-II → Pump-probe experiments

9. FET structures:

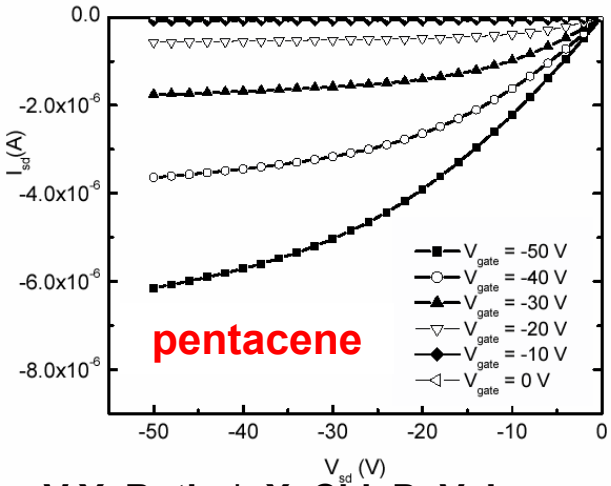
FM semiconductors



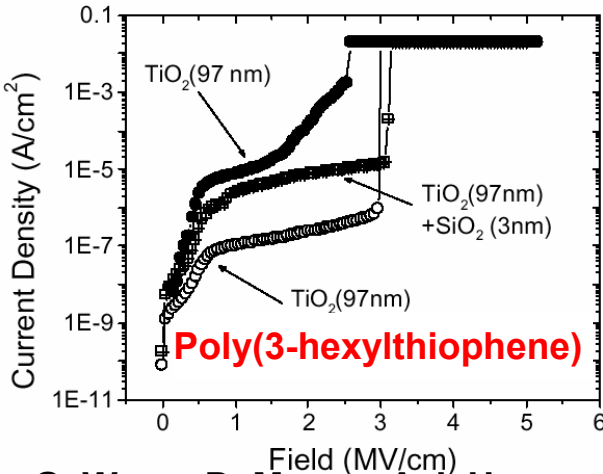
H. Ohno, D. Chiba, F. Matsukura, T. Omiya, E. Abe, T. Dietl, Y. Ohno& K. Ohtani, Nature 408, 944 (2000).

Organic molecular crystals

Polymers

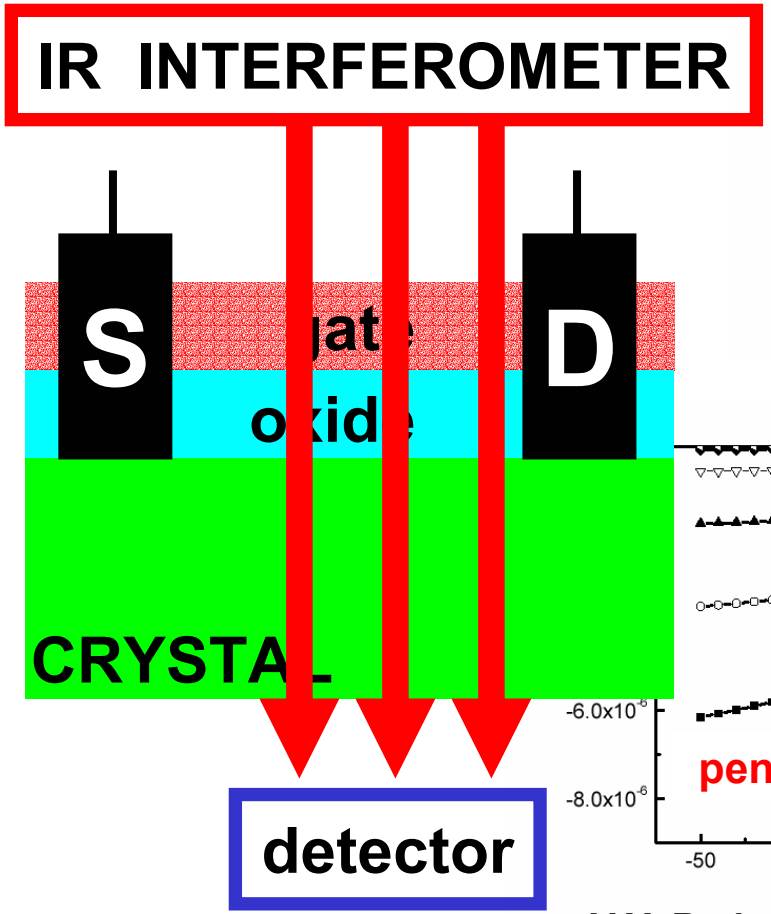


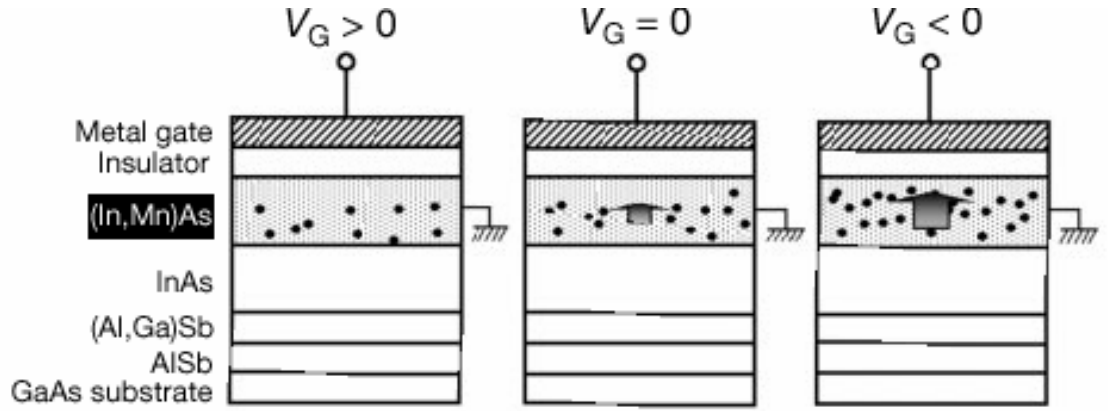
V.Y. Butko*, X. Chi, D. V. Lang, A.P. Ramirez cond-mat/0305402



G. Wang, D. Moses, A.J. Heeger, J. Applied Phys. (in press)

9. FET structures





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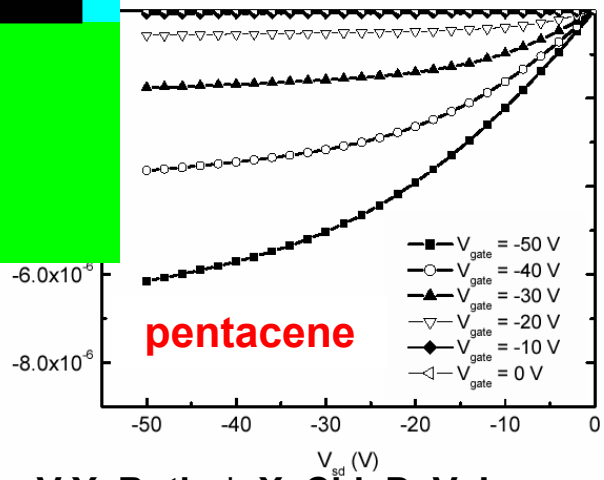

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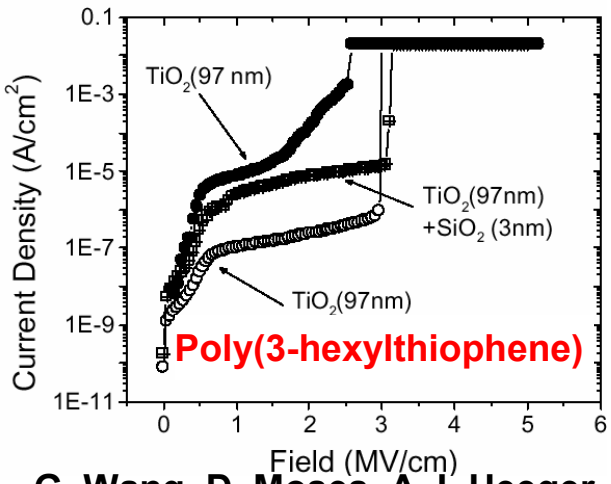

G. Wang, D. Moses, A.J. Heeger, J. Applied Phys. (in press)

Experimental issues:

"transparent" gates

IR @ NSLS-II → Signal intensity!!!!

IR Spectroscopy @ NSLS-2 and Physics of Strong Correlations

- Instruments for broad range spectroscopy:
  (80 GHz - 30 eV)
- “Coherent” radiation for sub-THz region
- Spectroscopic ellipsometry
- Pump-probe experiments
- Micro-sample capabilities
- High magnetic field