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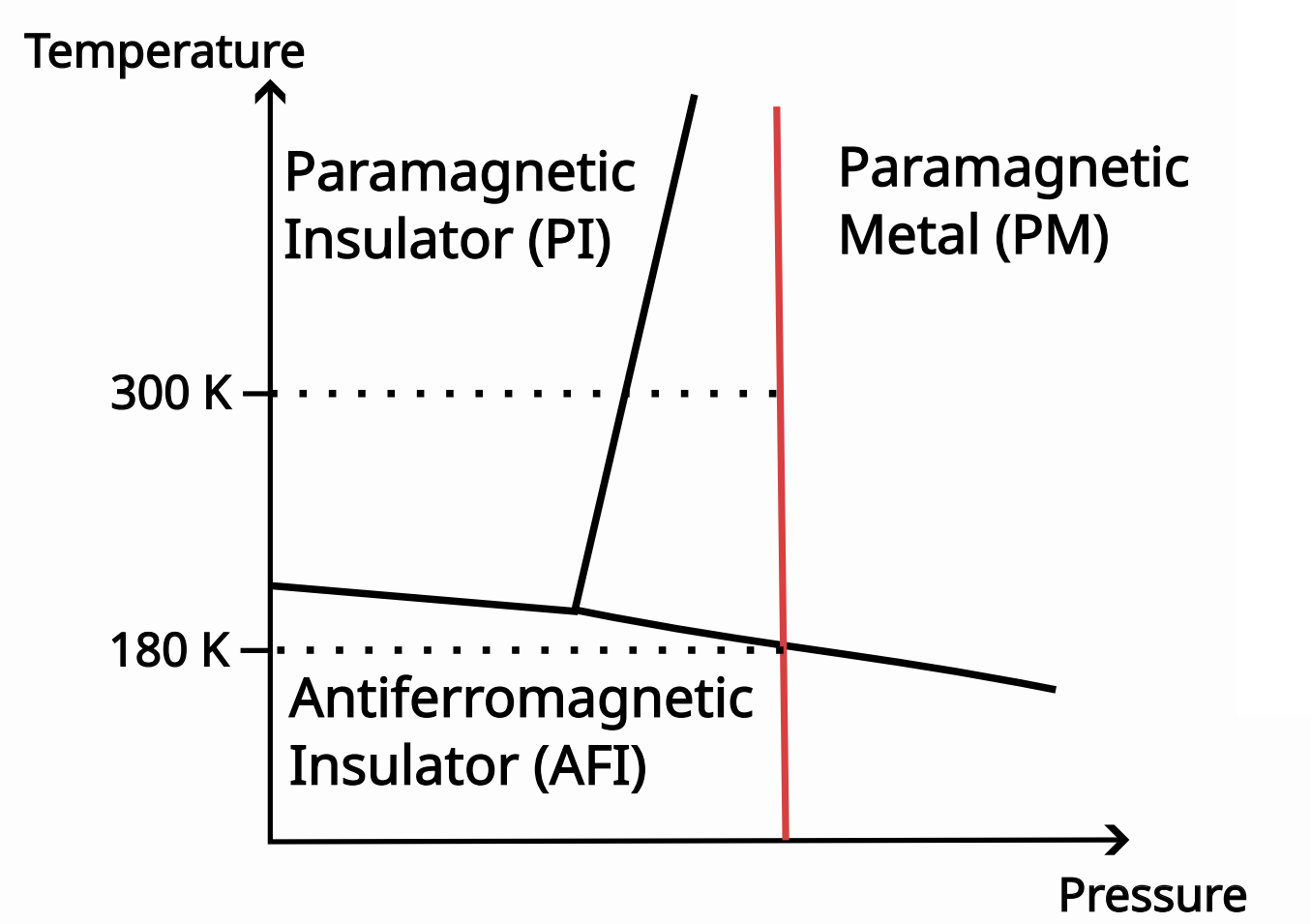
Coherent structural dynamics in V_2O_3 under hydrostatic pressure

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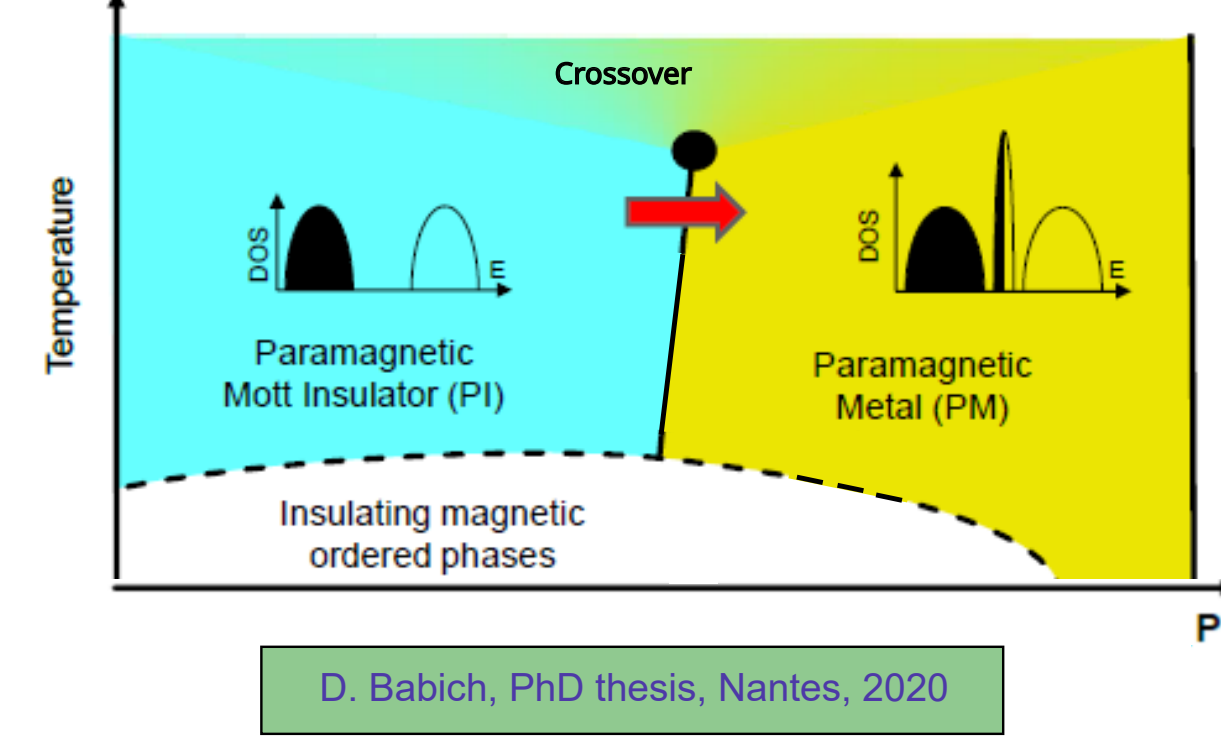
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Impact of Pressure, Temperature and Excitation Density on photo-induced A_{1g} optical mode?

V_2O_3 prototypical Mott Insulator



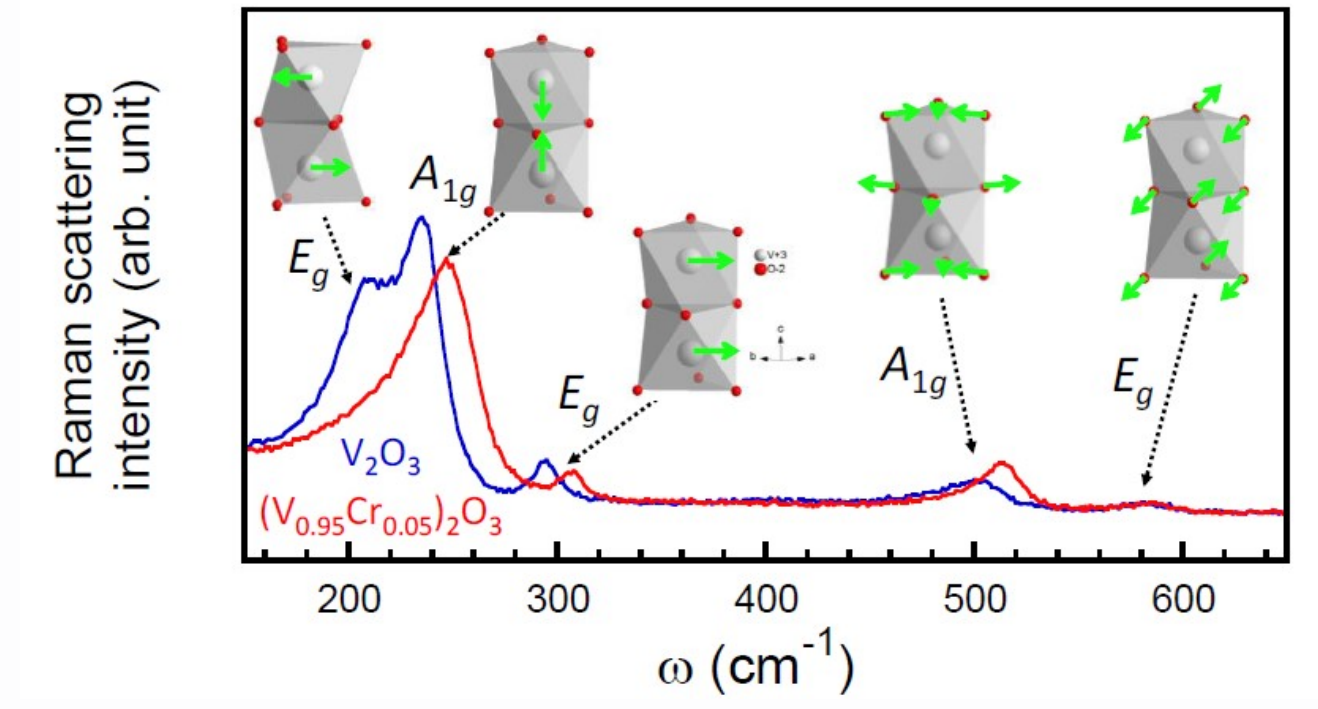
- Mott Insulator: material presenting insulating phase despite its electronic bandstructure suggesting metallic behavior
- Red line: expected position in the phase diagram of pure V_2O_3



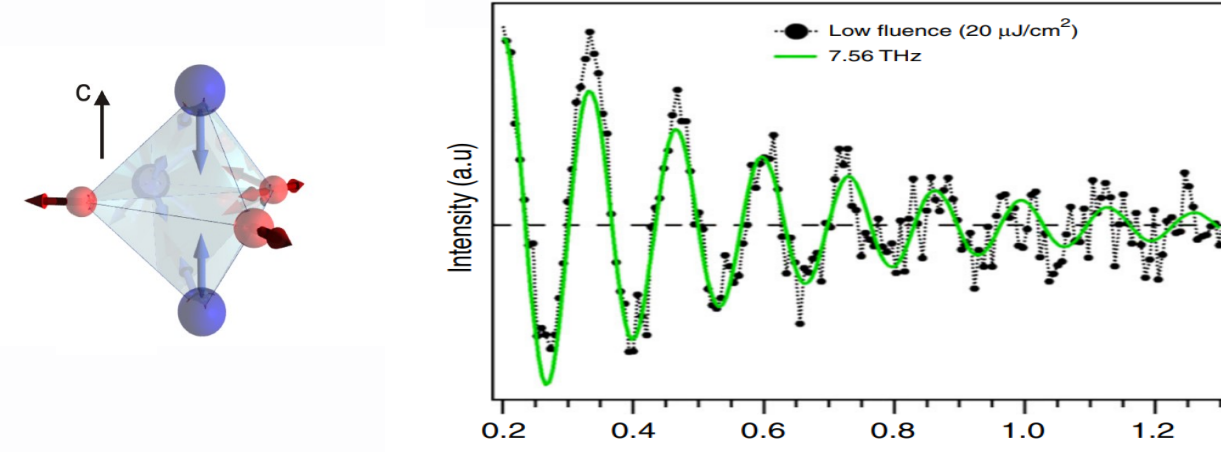
- Electronic bandwidth impact the Insulator to Metal transition
- Crossing the PI-PM line by applying pressure
- Pressure enhances orbital overlap \rightarrow enlarging the bandwidth

Spectroscopy of coherent phonons

- Photo-excitation induces the generation of coherent optical phonon within DECP mechanism (Displacive Excitation of Coherent Phonon)
- Observation of one single frequency around 7 THz; in agreement with A_{1g} frequency (Raman)



Ramans Modes of V_2O_3 , in the PI (red) and PM (blue) phases



Spatial representation of the A_{1g} optical mode and pump-probe reflectivity at 295 K

Lantz, G. Nat Commun 8, 13917 (2017)

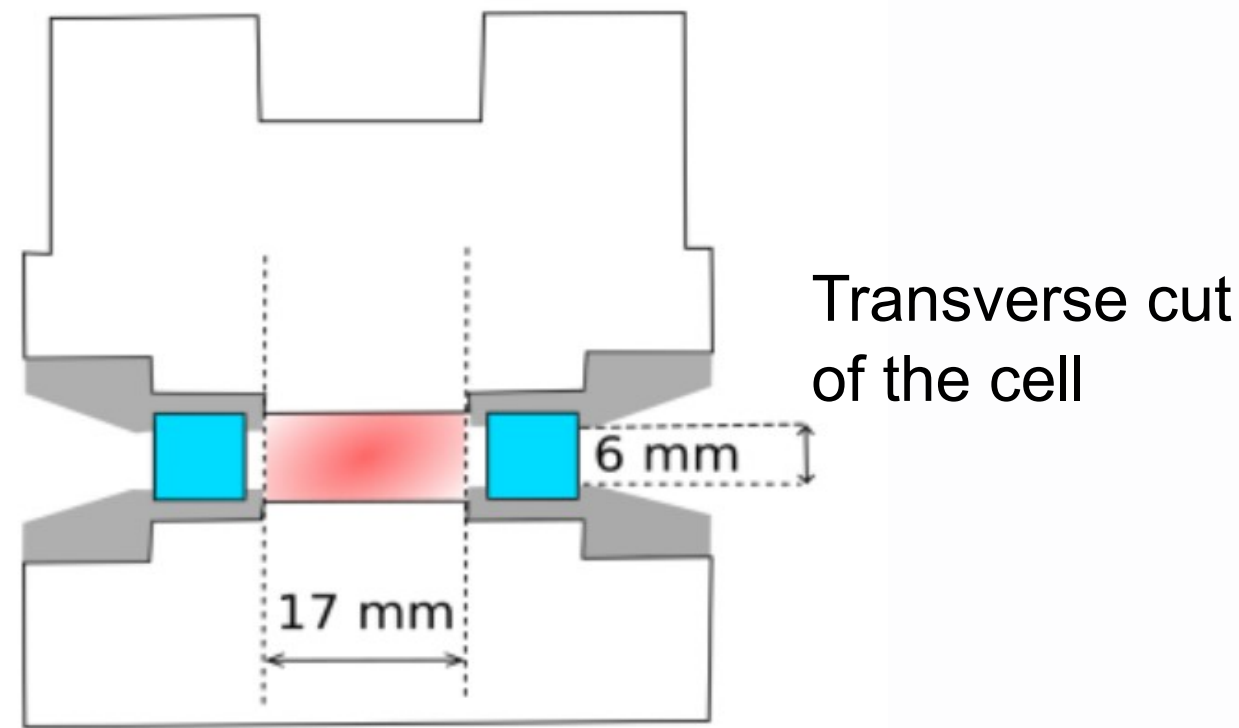
Goals:

- Performing ultrafast spectroscopy on "strained" V_2O_3 thin film (PI phase) under pressure
- Monitoring the evolution A_{1g} mode with thermodynamical control (Temperature, Pressure)

Spectroscopy of coherent phonon across V_2O_3 PI-PM phase transition

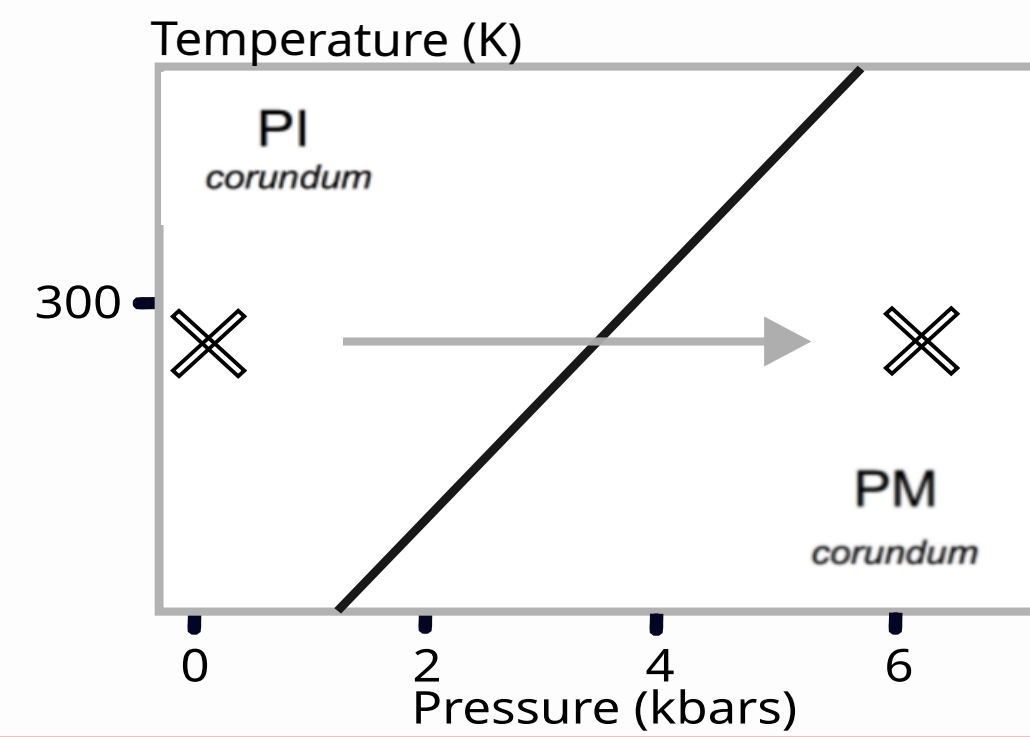
High Pressure Cell

- Helium gas high pressure set up
- Hydrostatic pressure from 1 to 7000 bars
- Sapphire windows allowing optical Transmission/Reflection



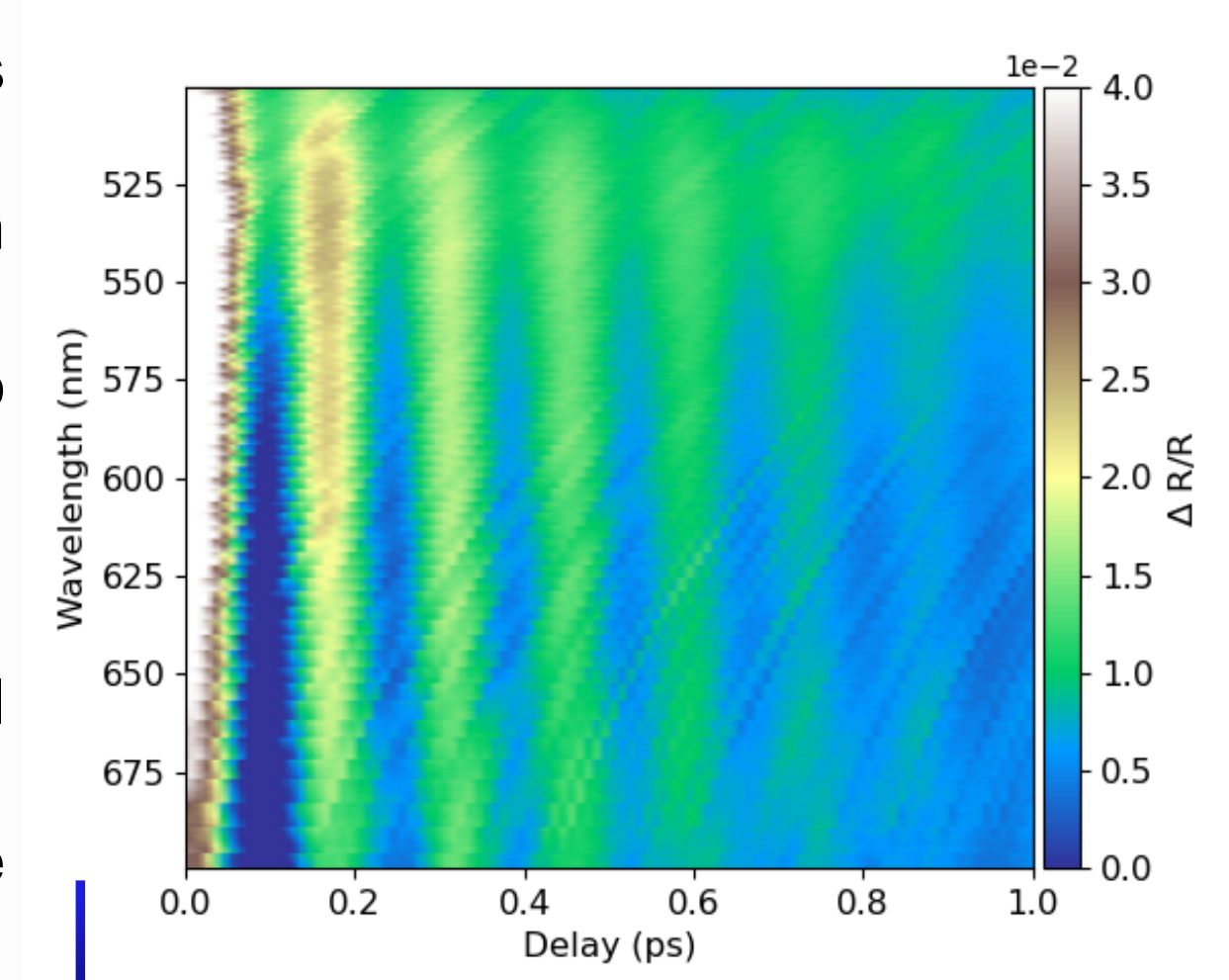
Experimental parameters

- Pump 800 nm ($=1.55$ eV), above bandgap
- Residual stress = PI phase under ambient conditions
- Room temperature
- 200 nm thin film



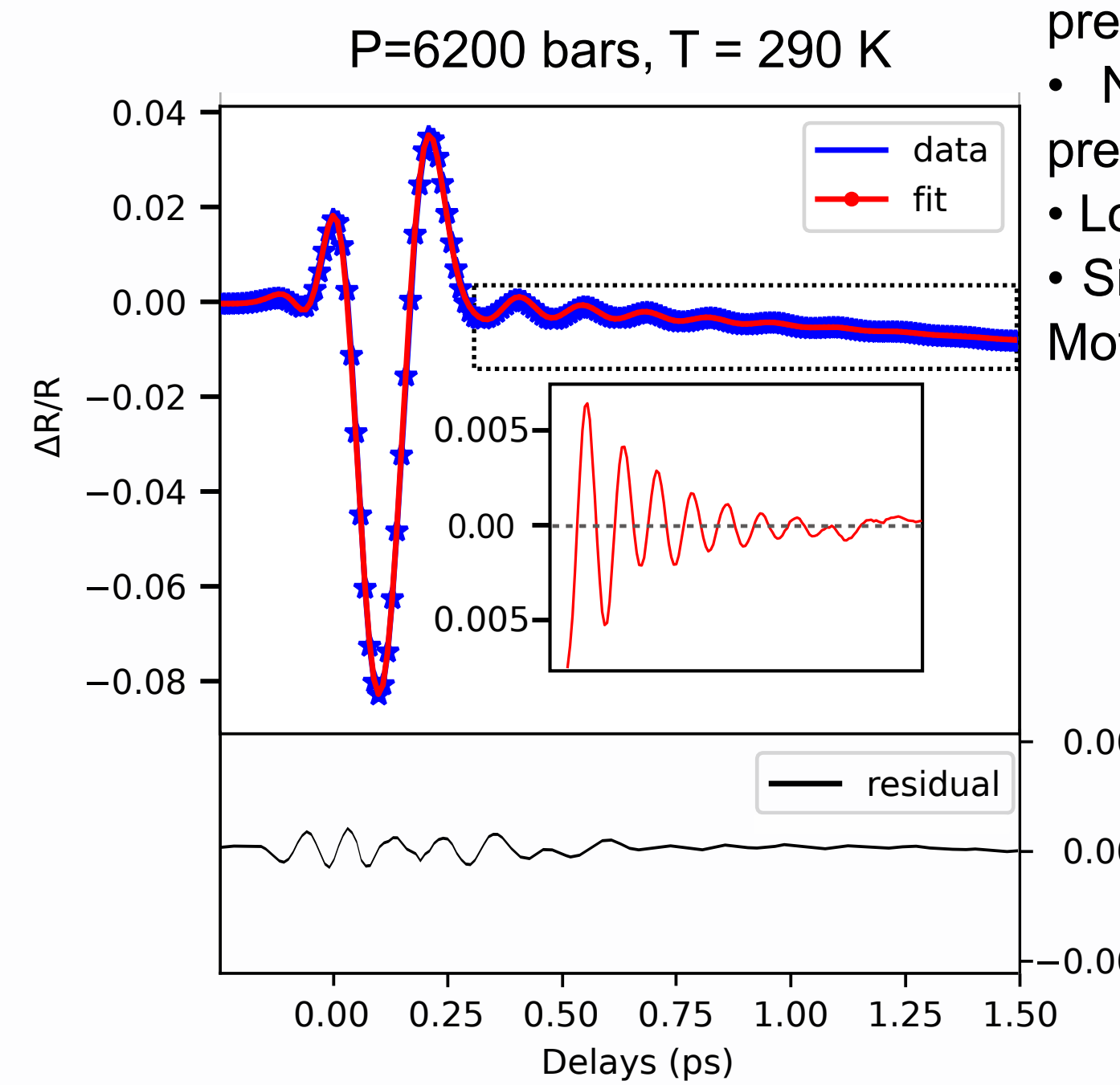
Experimental Data

- Ultrafast reflectivity changes following femtosecond excitation
- Monitoring the photo response in function of pressure
- Probe supercontinuum from 450 to 750 nm
- Time resolution around 80 fs
- Data are chirp corrected
- Oscillation modulating the full spectral range lasting up to 1 ps
- No wavelength dependency of the oscillation frequency

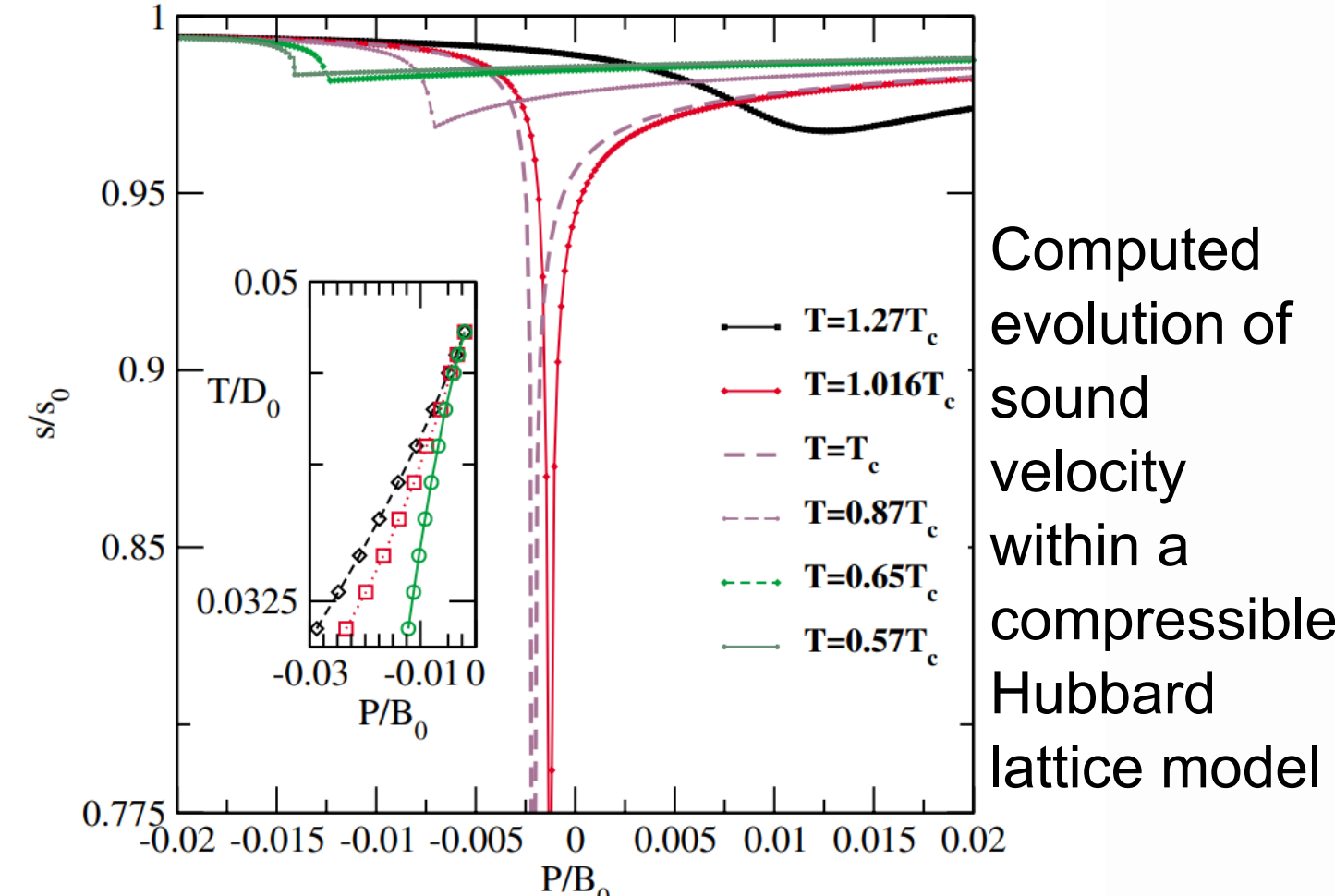


Data treatment and observations

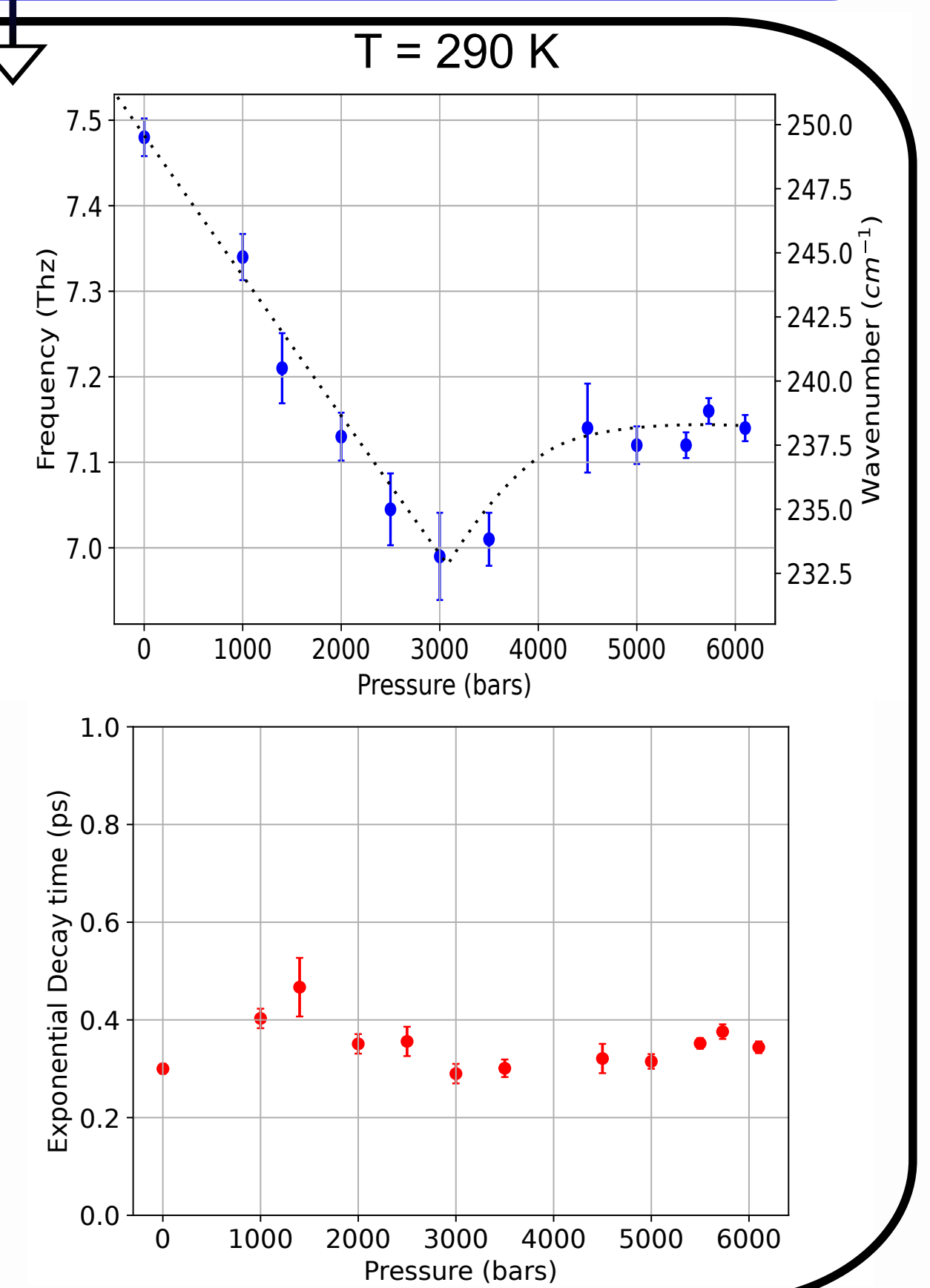
- Transient Reflectivity around 675 nm with 800 nm photo excitation
- Raw data points are shown in blue points and fit in red solid line. Bottom, residual component of the fit.
- Insert shows the oscillatory component
- Fit with 3 contributions
 - Non linear effect at time zero + electronic excitation
 - Oscillatory component from coherent phonon
 - Thermo-elastic effects



- Extracting A_{1g} frequency and damping as a function of pressure
- No obvious dependency of the damping time with pressure
- Lowest value of phonon frequency around 3 kbars
- Similar behavior as the sound velocity observed in other Mott materials



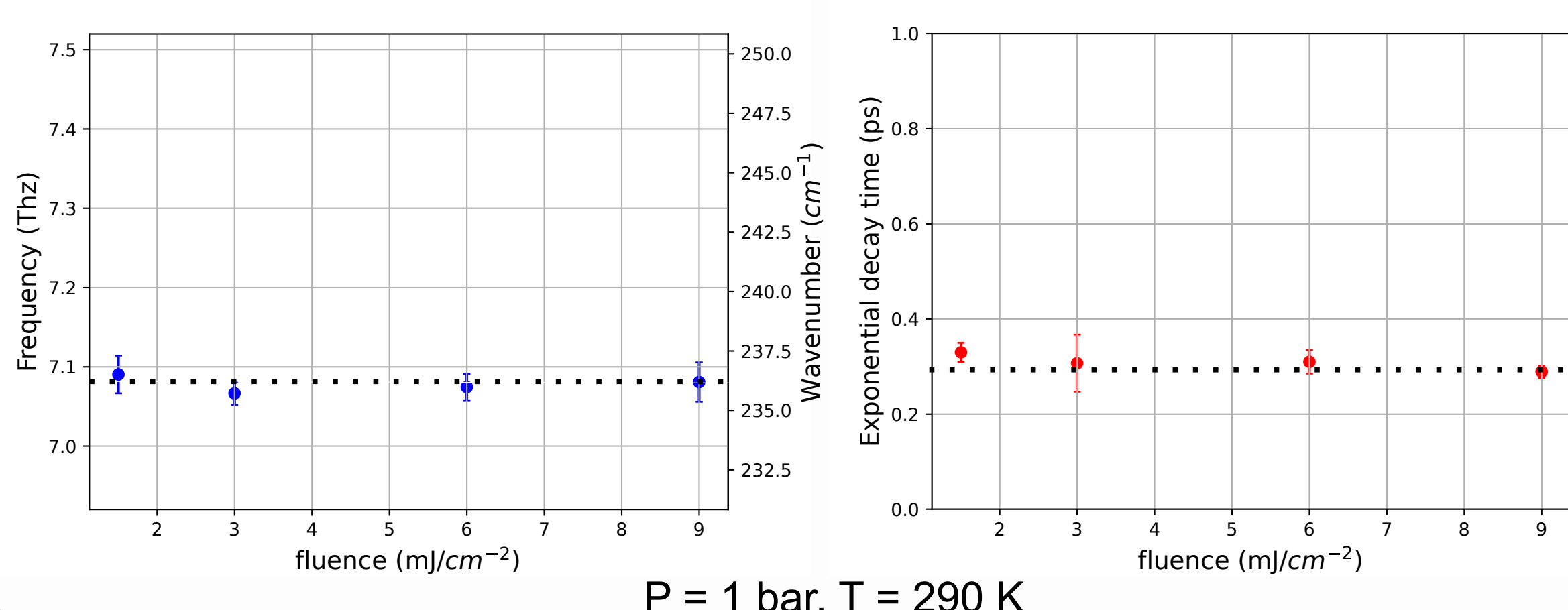
S.R.Hassan, Phys. Rev. Lett. 94, 036402 (2005)



Impact of the temperature and excitation density on structural dynamic in V_2O_3 (PM phase)

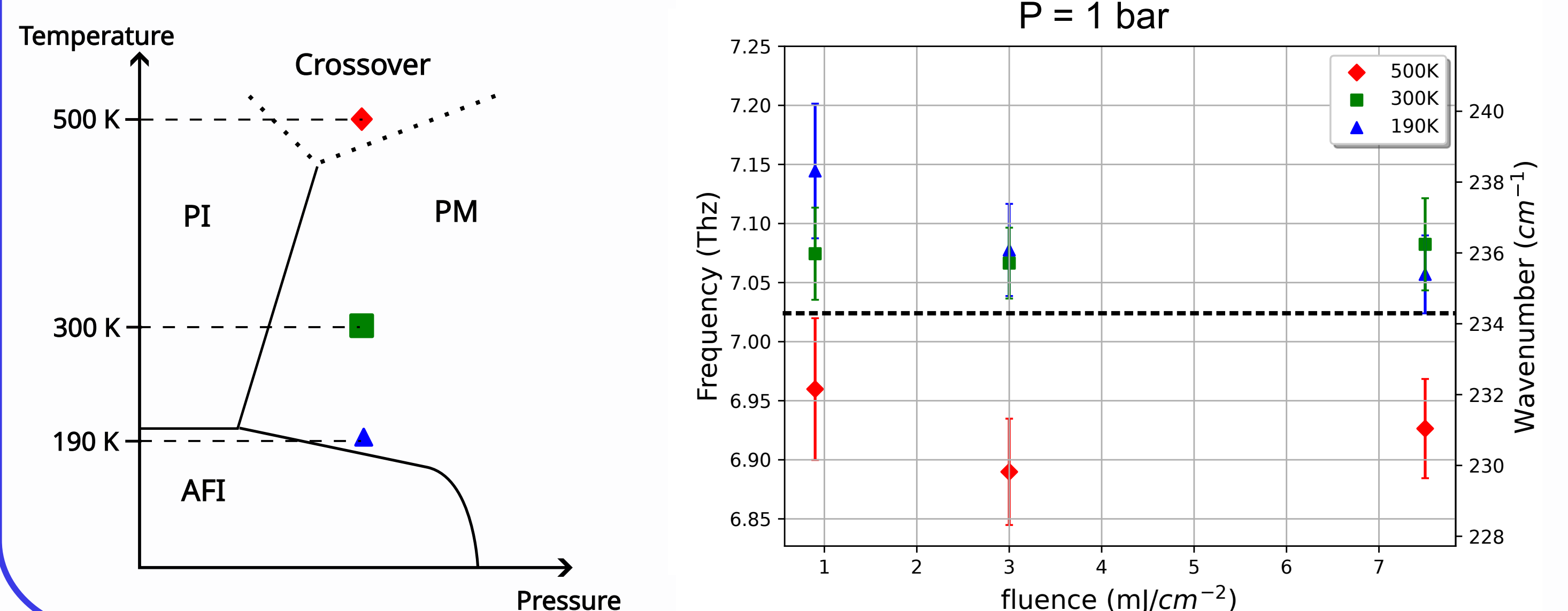
Excitation density

- From 1.5 to 9 mJ/cm^2
- No influence from the excitation density
- No influence on the damping time
- Different from Bismuth (softening) or Gold (hardening)
- The excitation density does not impact the lattice potential



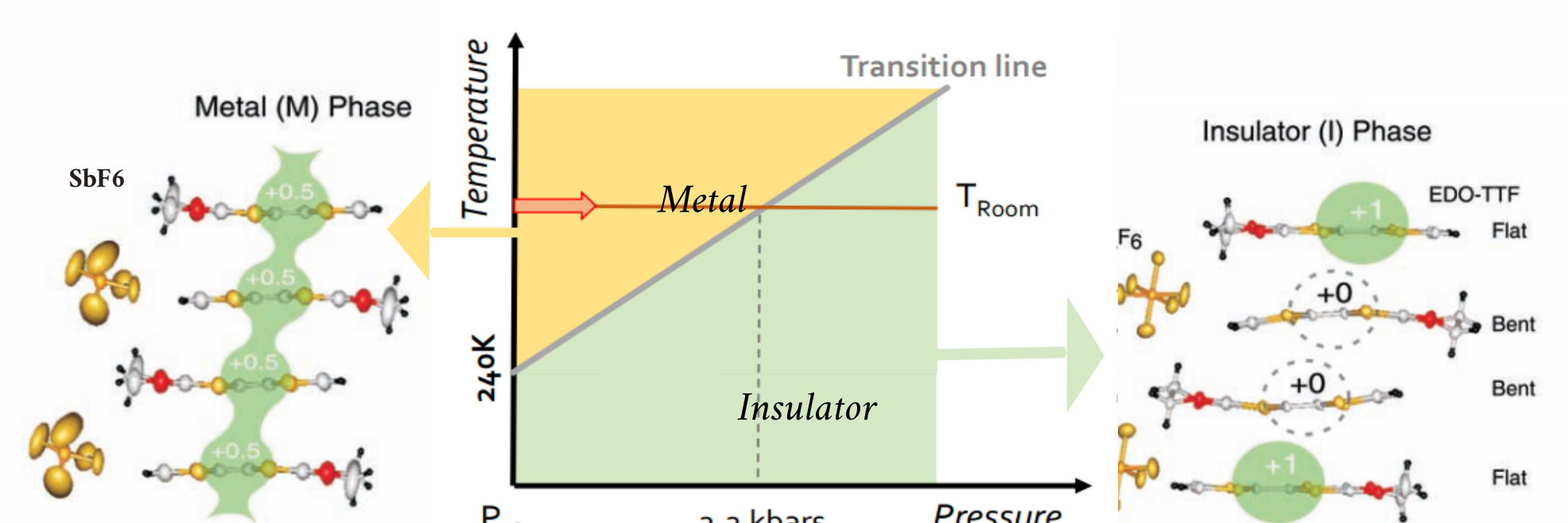
Temperature

- From 190 K to 500 K
- Softening of the A_{1g} mode at 500 K (Crossover region)
- No evolution of the frequency with the excitation density



Outlooks

- Exploring the Pressure/Temperature phase diagram of molecular material
- Using Pump-Probe experiment to study optical response of different phase, follow electronics and structural dynamics
- Application to molecular materials: (EDO-TTF)SbF₆



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