

Imaging the itinerant-to-localized transmutation of electrons across the metal-to-insulator transition in V_2O_3

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Team of correlated electrons @ ISMO



**Andrés F.
Santander-Syro**



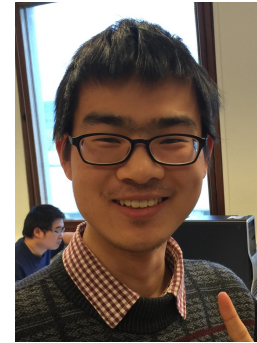
Franck Fortuna



**Emmanouil
Frantzeskakis**



**Max Thees
2022**



**Ji Dai
2019**



**Amitayush
Jha Thakur - D3**



Emma David - D2



**Alexandre
Antezak - D1**



**T. C. Rödel
2016**



**C. Bareille
2013**



**Pedro Rezende -
PostDoc**





Collaborators



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Julien Rault**

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Juan Trastoy
Ivan K. Schuller**



Silke Biermann



Marcelo J. Rozenberg

UNIVERSITY OF TWENTE. | MESA+ INSTITUTE

Rosa Luca Bouwmeester



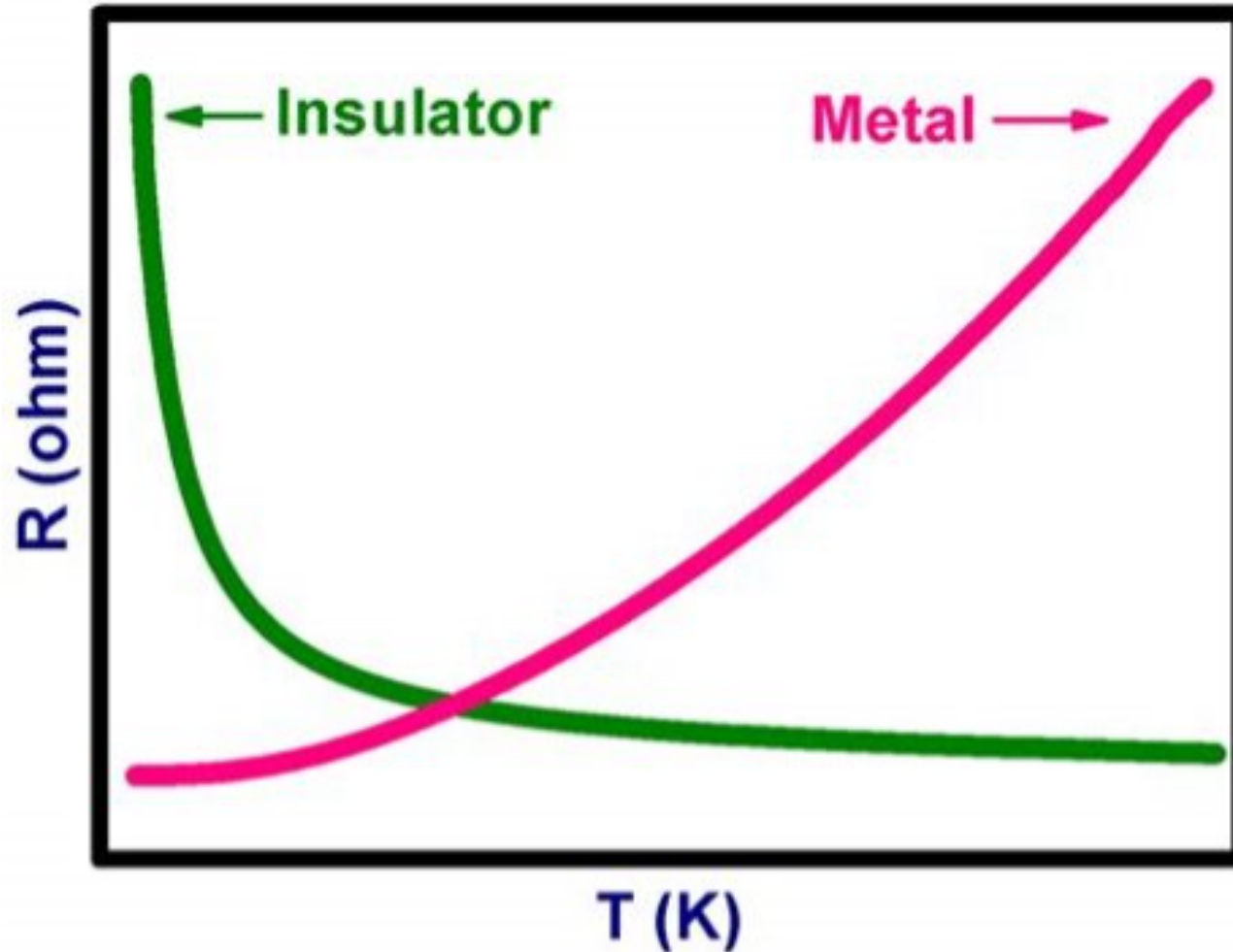
Alexandre Zimmers



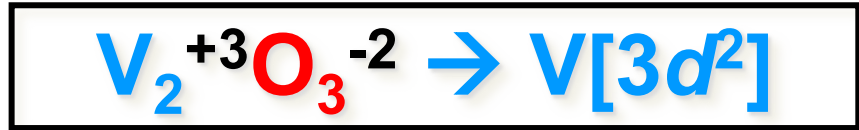
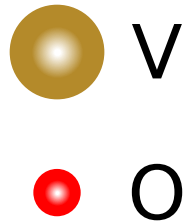
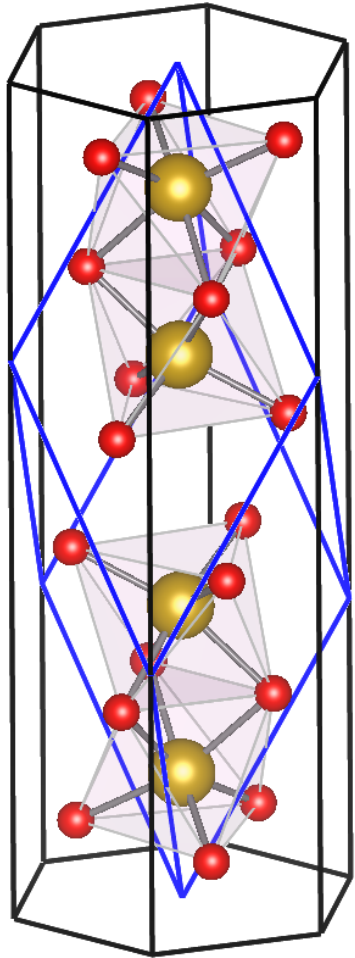
**Koji Horiba
Hiroshi Kumigashira**



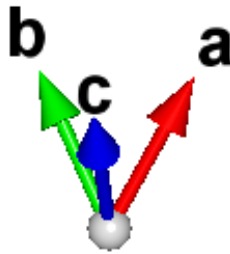
The “Standard Model” of Condensed-Matter Physics

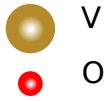
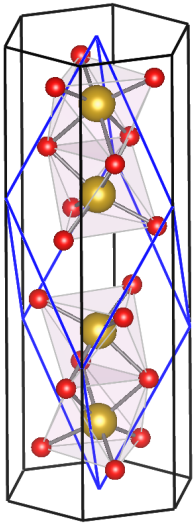


How about V_2O_3 ?

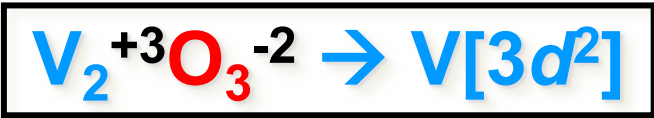


→ It should be a metal!

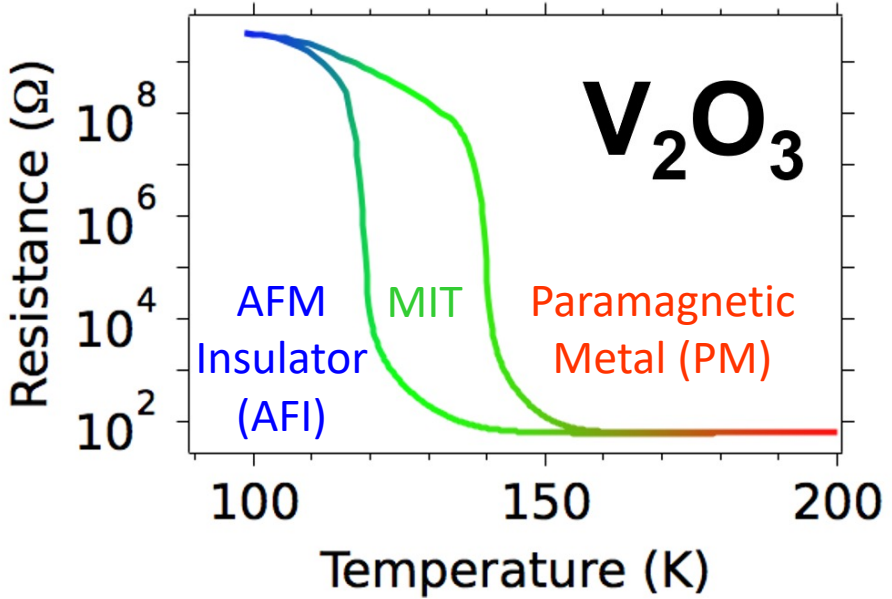
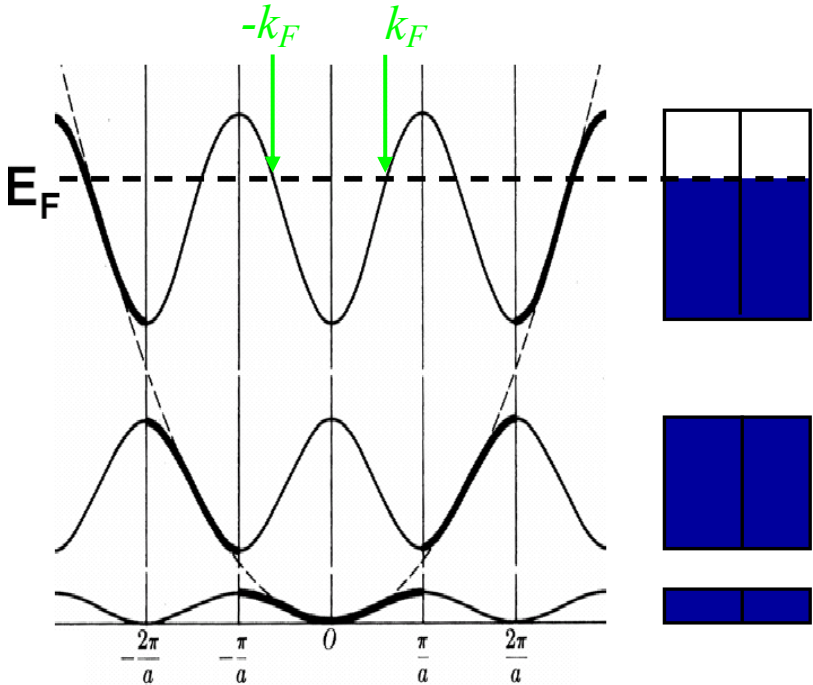


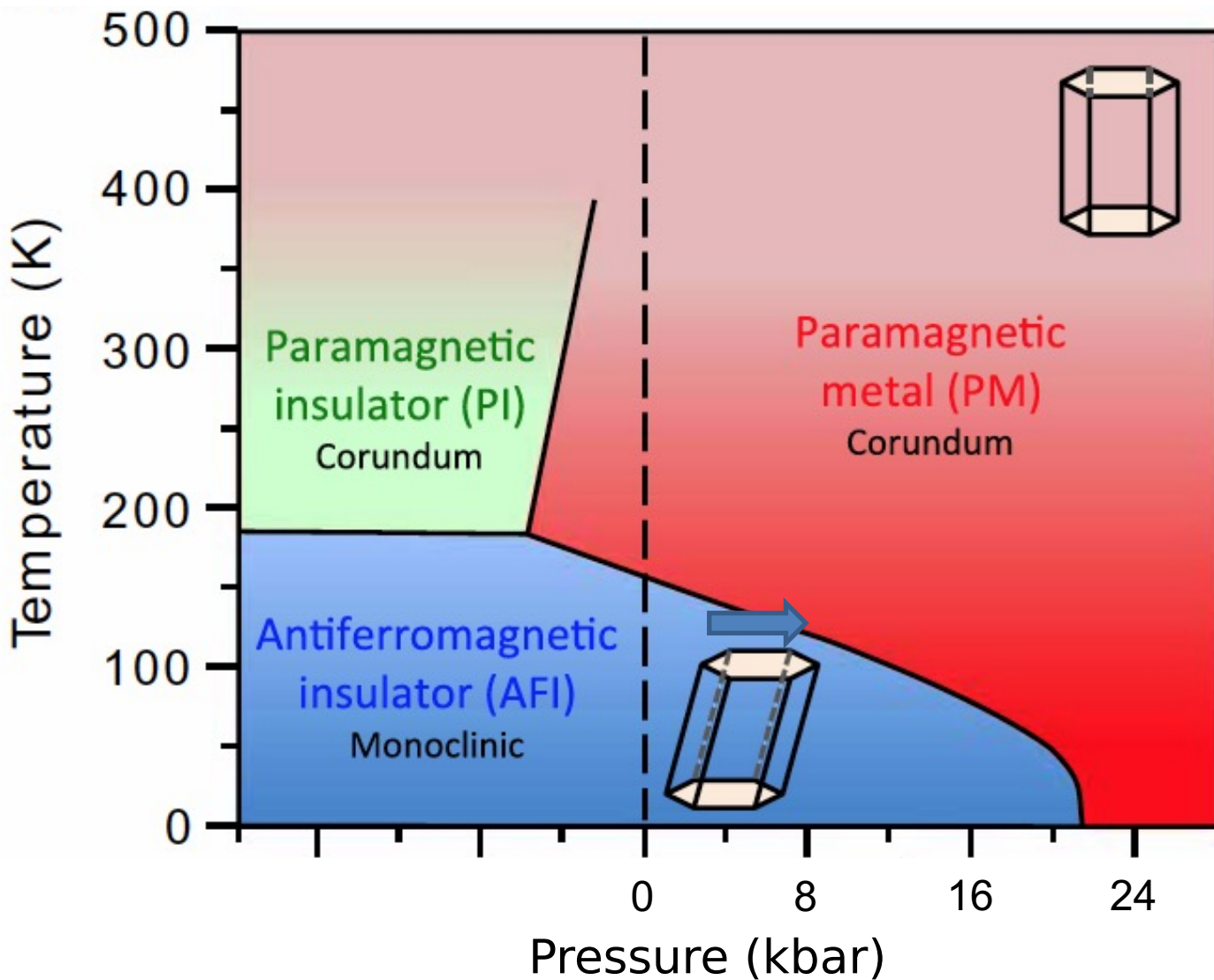
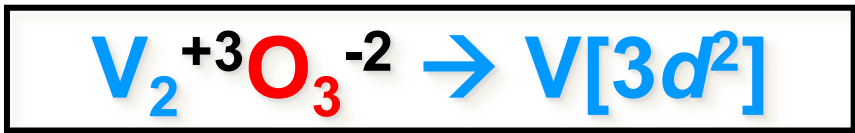
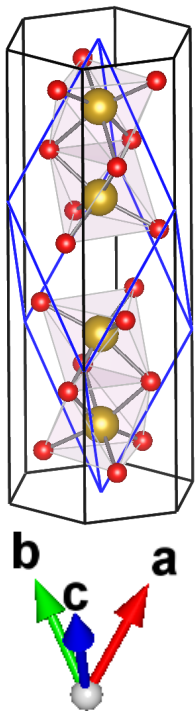


Metal-Insulator Transition



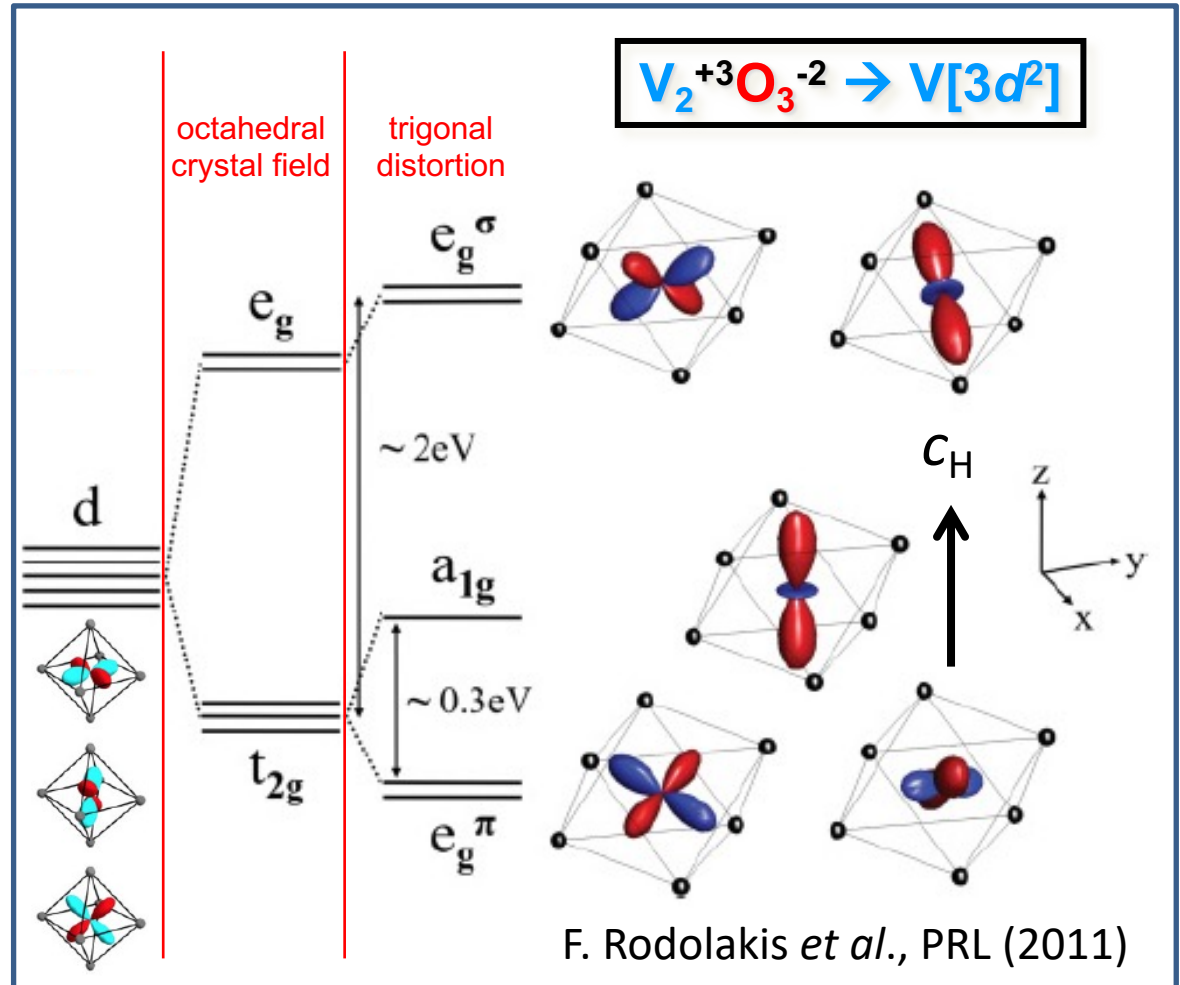
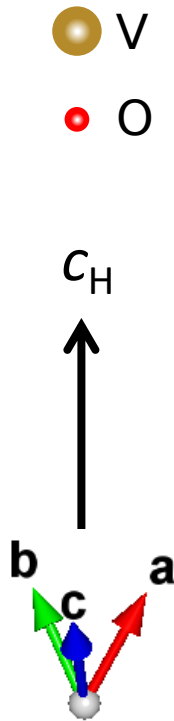
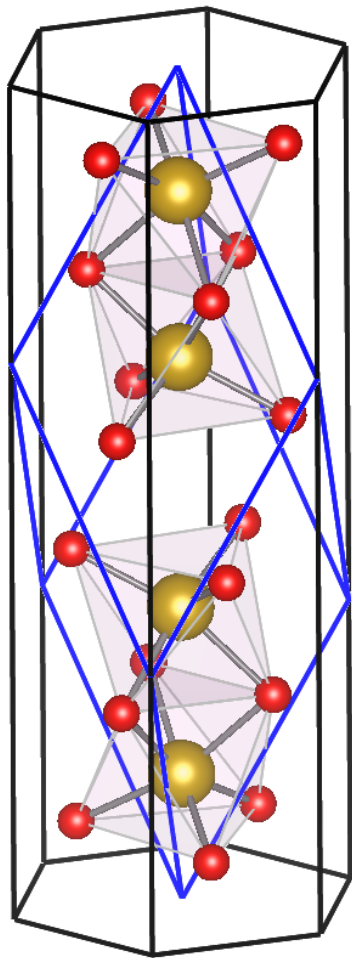
→ It should be a metal!



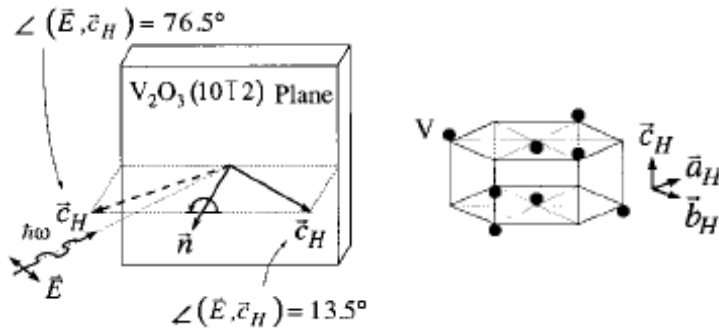
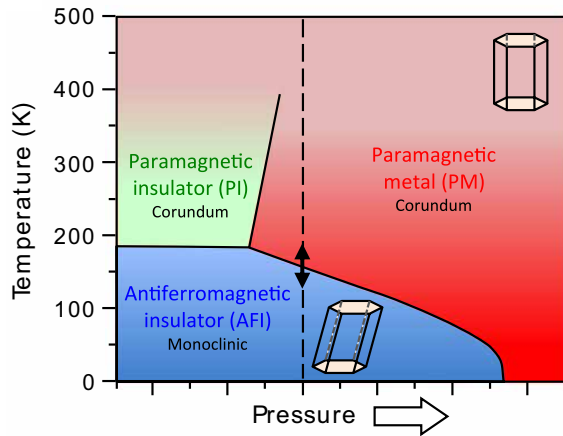


V₂O₃:

a half-filled single-orbital system?

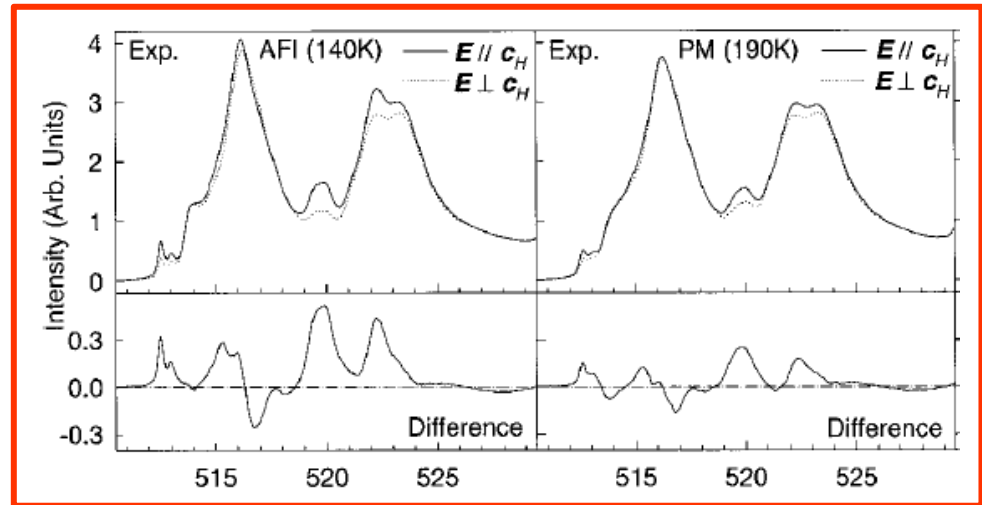


V₂O₃: evidence for multiple orbital occupancy in both the PM and AFI phases

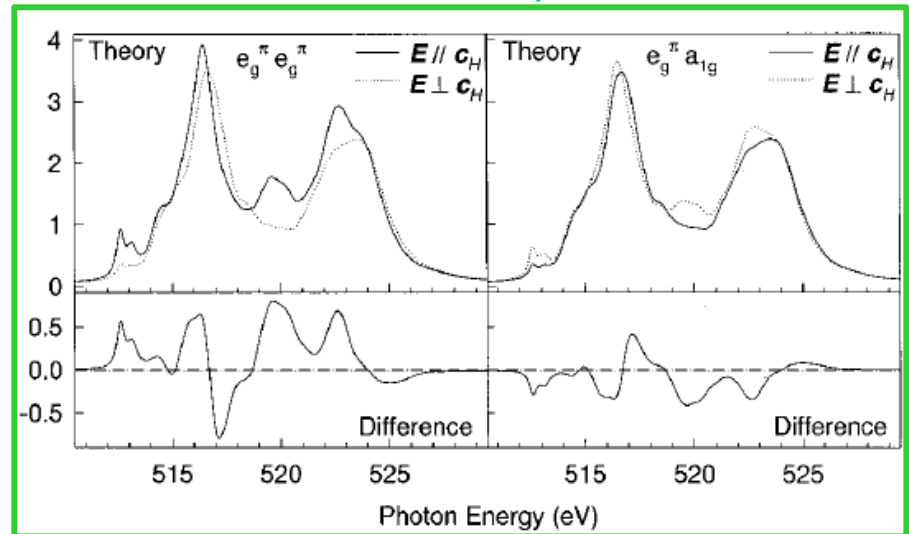


Phase	$e_g^\pi e_g^\pi : e_g^\pi a_{1g}$
PM	1:1
AFI	2:1

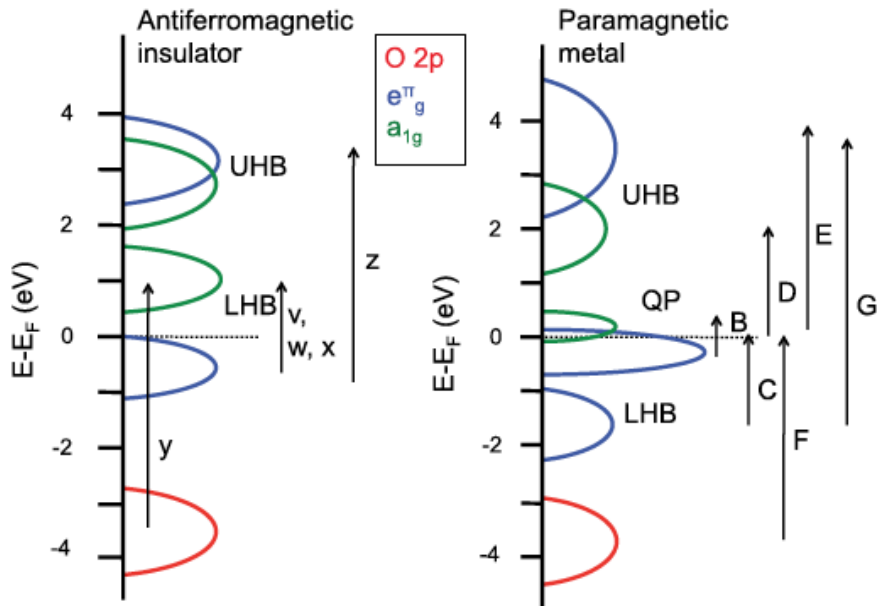
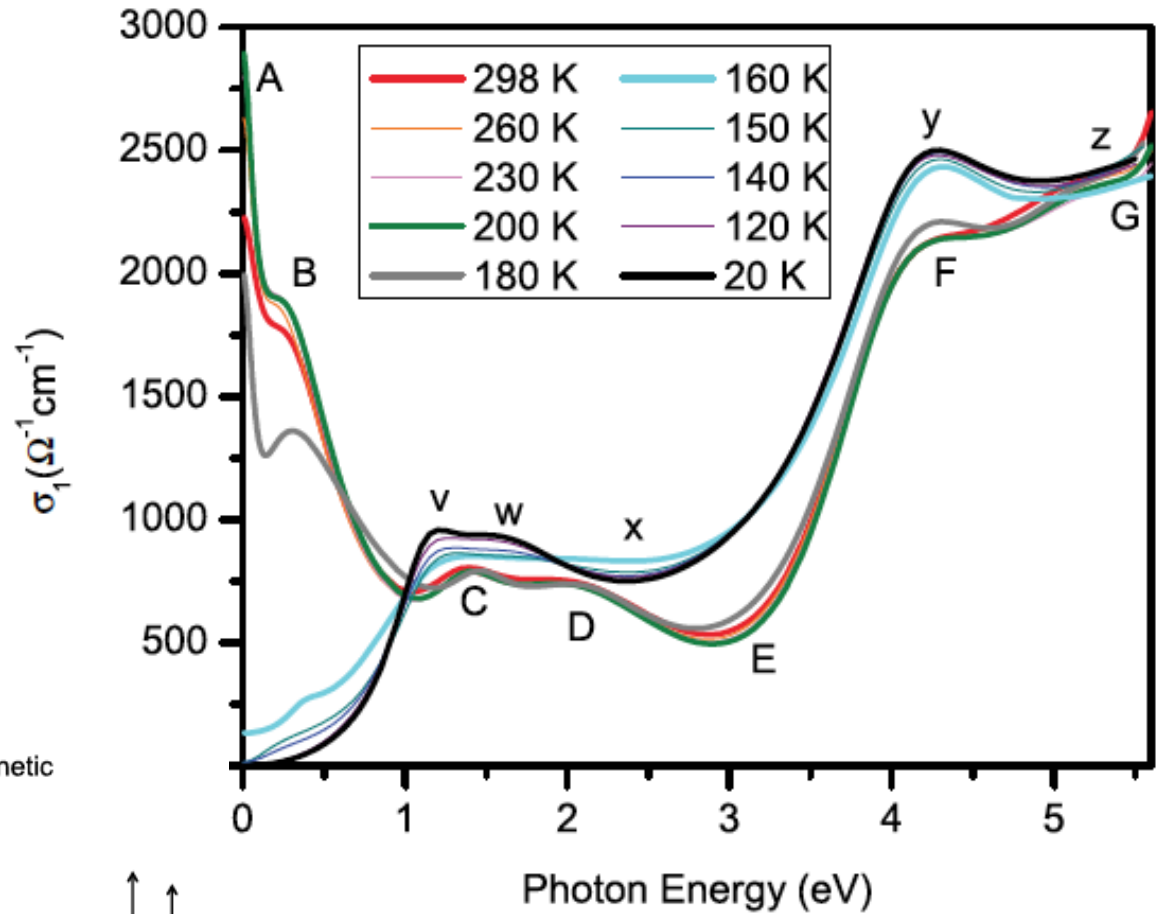
Polarization-dependent L-edge XAS



Theoretical curves from pure initial states



MIT in V_2O_3 : Optical conductivity

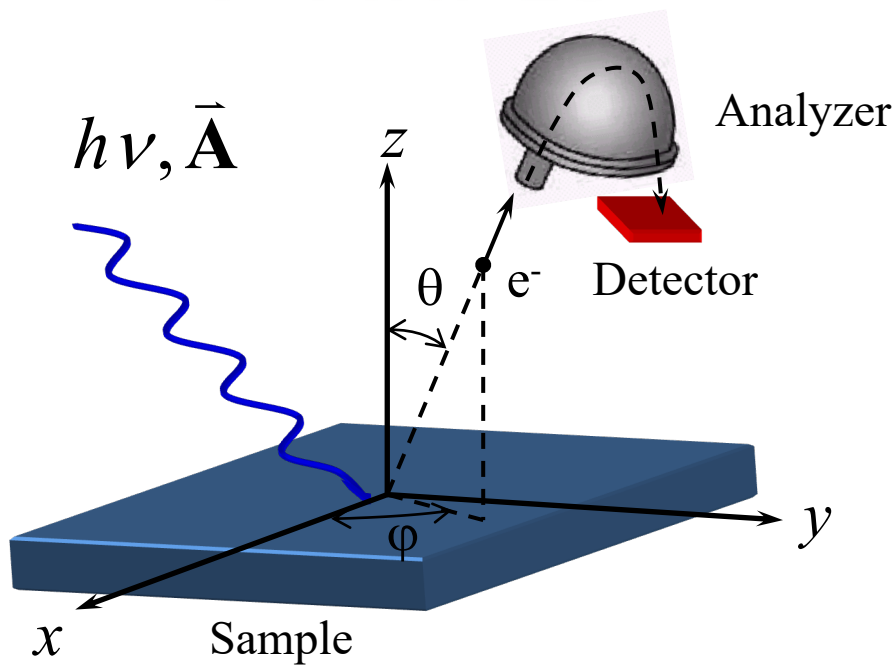


M. K. Stewart *et al.*, PRB **85**, 205113 (2012)
L. Baldassarre *et al.*, PRB **77**, 113107 (2008)

**How to understand further
the electronic structure of
the metal-insulator
transition?**

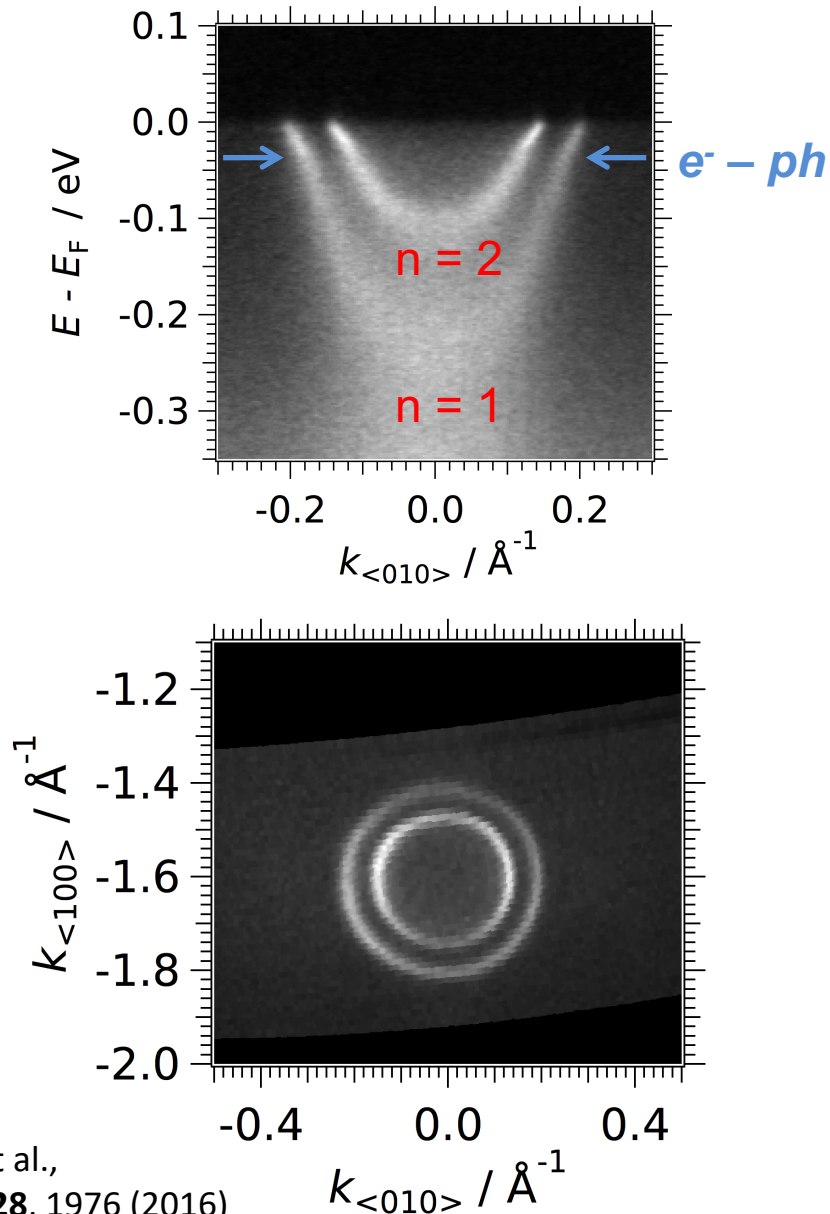
Measure $\varepsilon(\vec{k})$!

→ ARPES



$$E_{kin} = h\nu - W - |E_B|$$
$$\hbar\mathbf{k}_{\parallel} = \sqrt{2mE_{kin}} \sin \theta$$

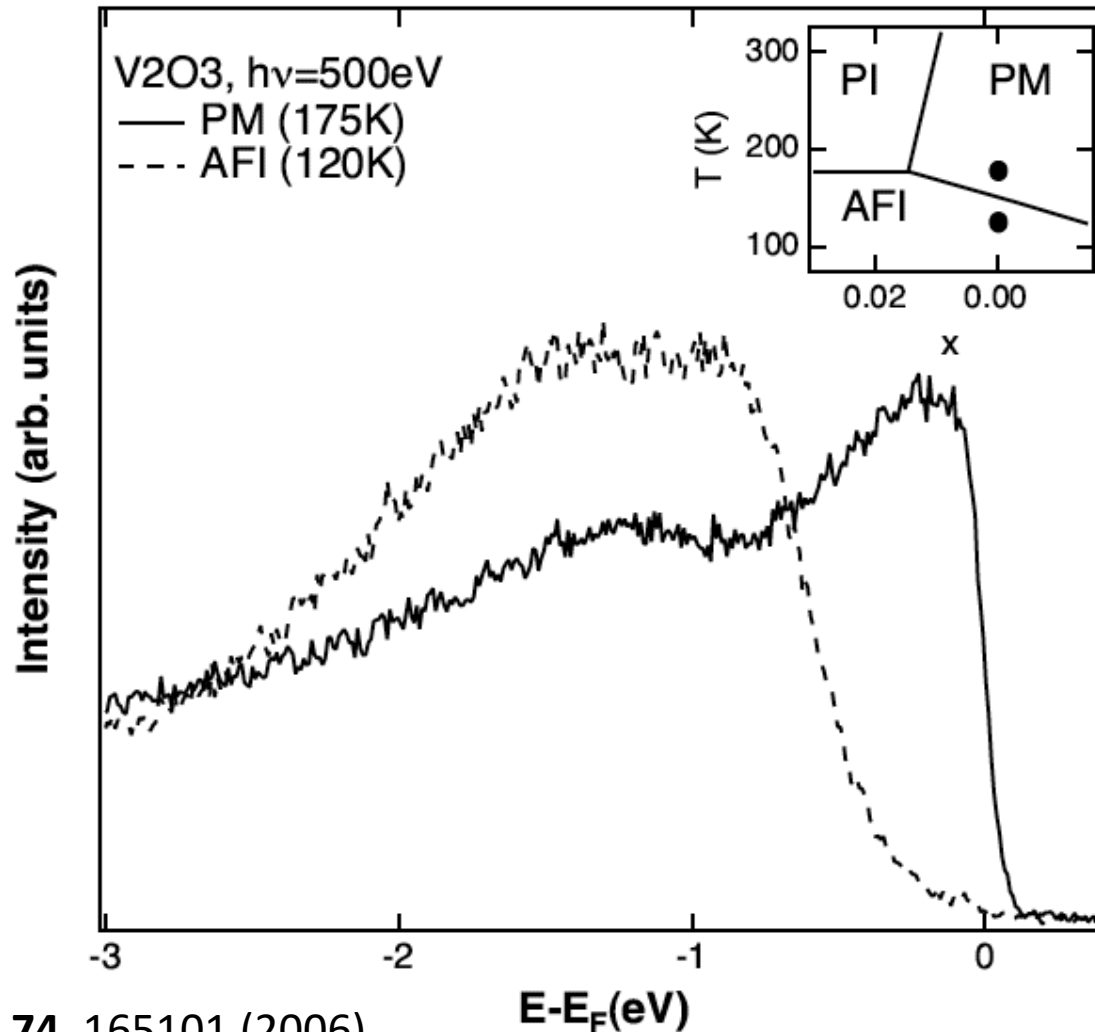
ARPES simple example:
2D electron gas in SrTiO₃



CASSIOPEE @ SOLEIL



Metal-insulator transition in V_2O_3 : Angle-integrated photoemission

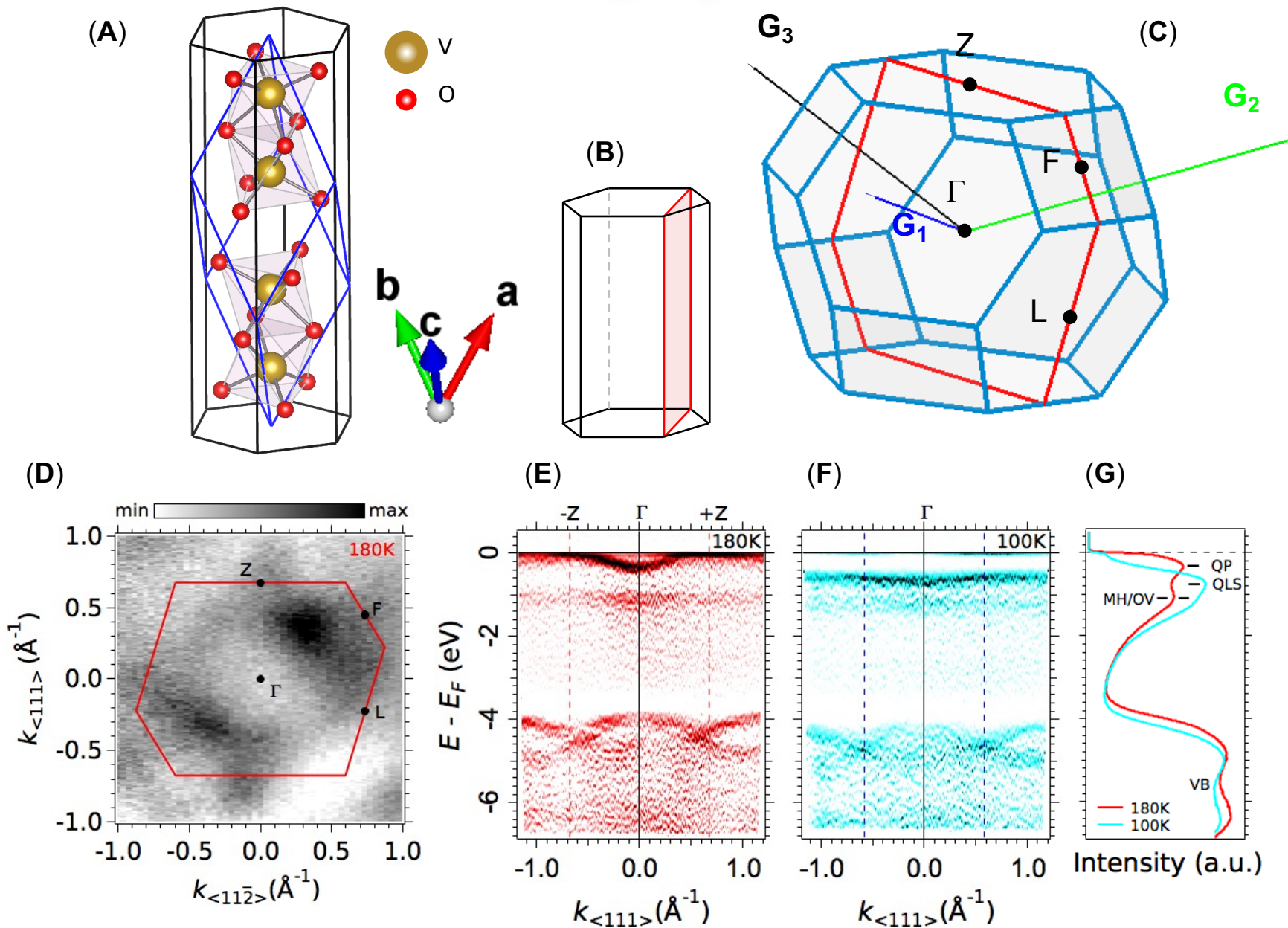


Open issue

How the electronic states change from the metallic phase to the insulating one?

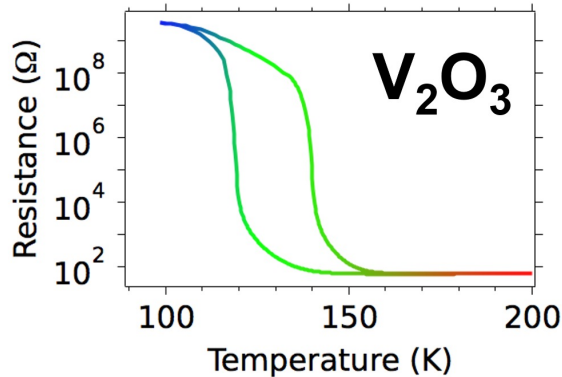
- Microscopic processes accompanying the Mott MIT: roles played by the electronic, magnetic, and structural degrees of freedom.
- **ARPES across the thermally-induced MIT of any Mott system still missing!**

ARPES in V_2O_3 thin films!



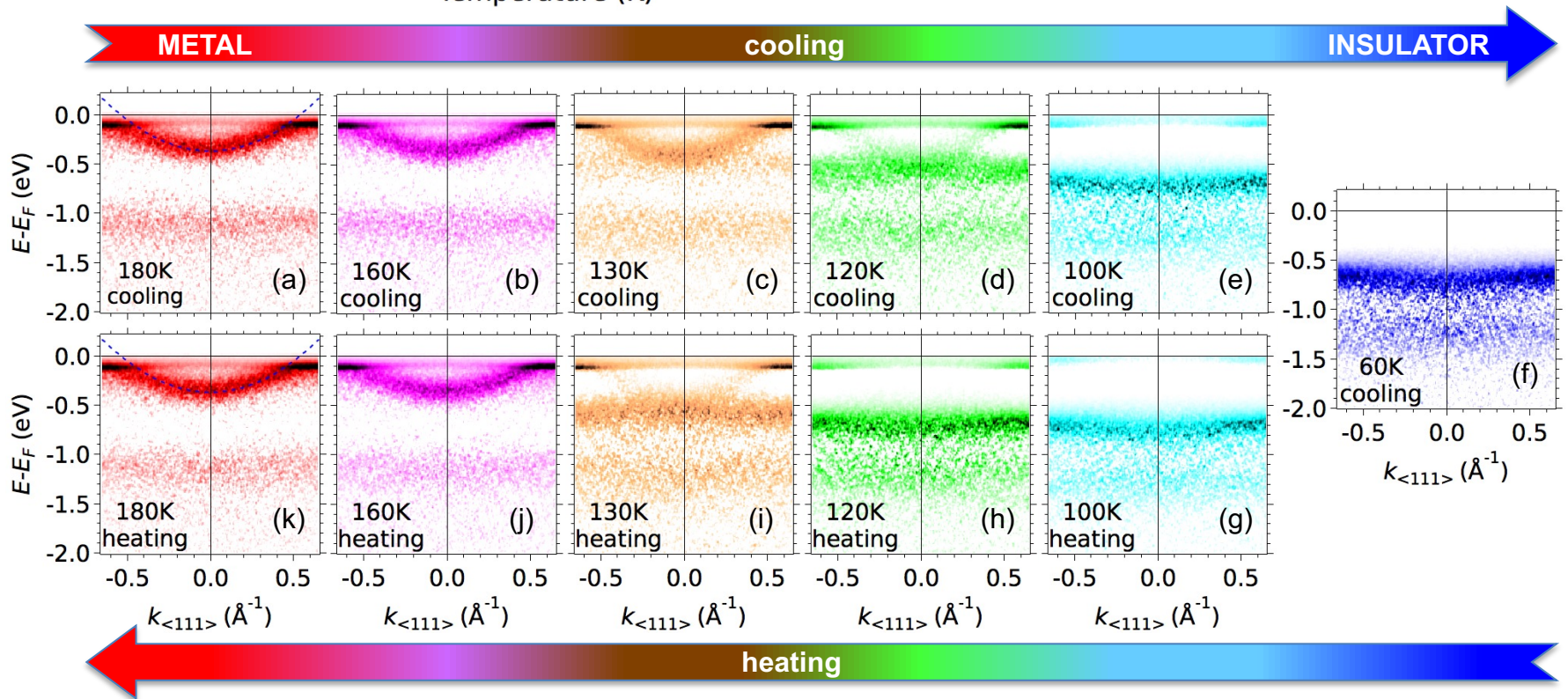
Metal-Insulator Transition in V_2O_3

ARPES view

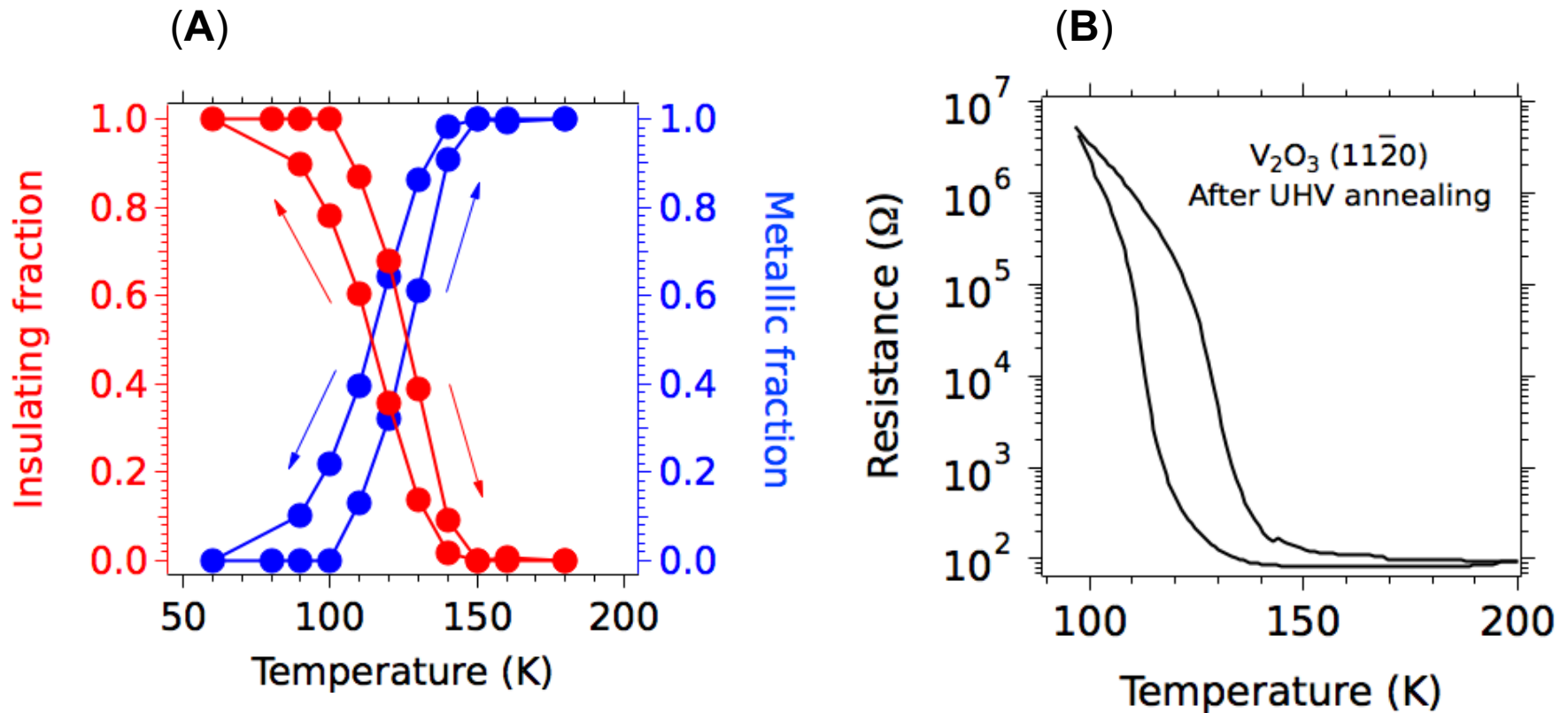


- The electronic structure changes across the MIT!
- It also shows hysteresis!

M. Thees *et al.*, Science Advances **7**, eabj 1161 (2021)



Hysteresis in the electronic structure across the MIT



M. Thees *et al.*, Science Advances **7**, eabj 1161 (2021)

Conclusions

