

# Magnetic Tunnel Junctions with an Organic Barrier

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under the mentorship of  
Dr. Jagadeesh S. Moodera

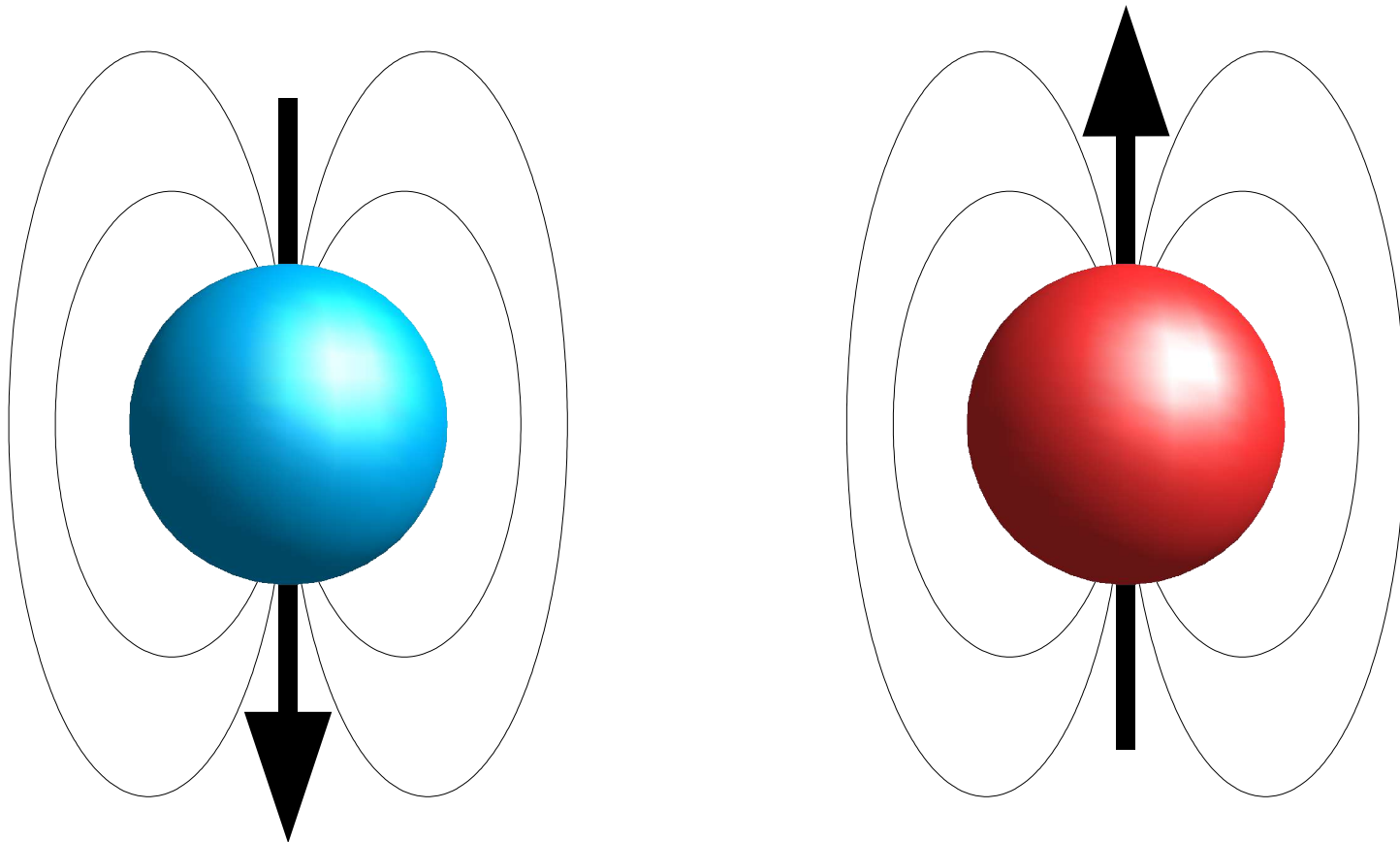
Francis Bitter Magnet Laboratory  
MIT

# Outline

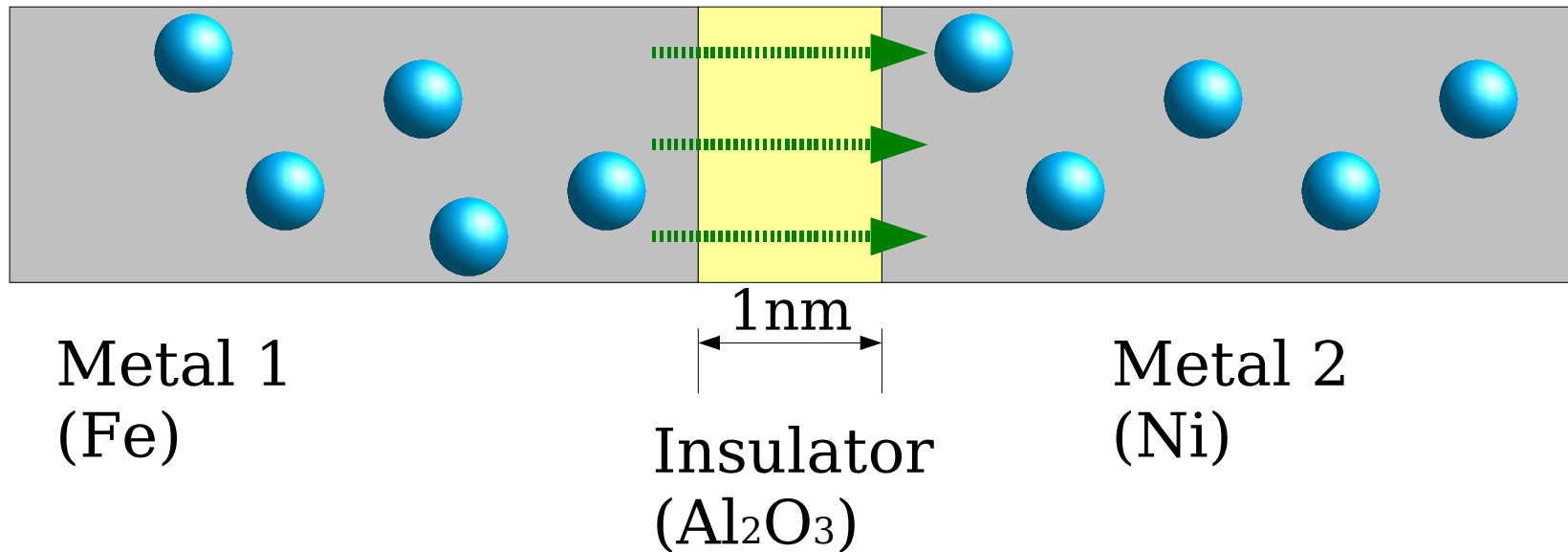
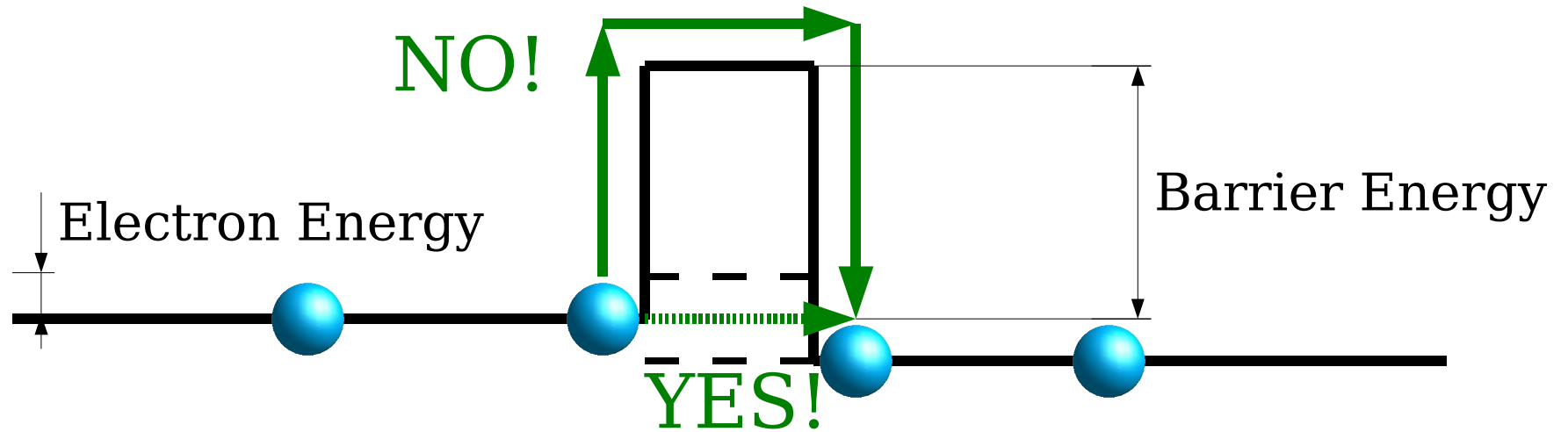
- Magnetic...
- ...Tunnel Junctions...
- ...Organic Barrier
- Crystal structure
- Tunnel Magnetoresistance (TMR)
- Conclusion
- Applications

# Magnetic...

Electrons have charge and spin,  
thus they are little magnets!



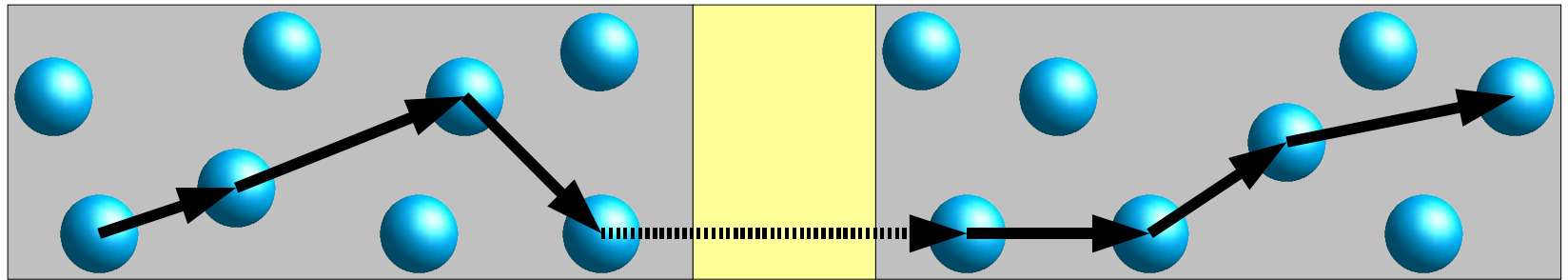
# ...Tunnel Junctions...



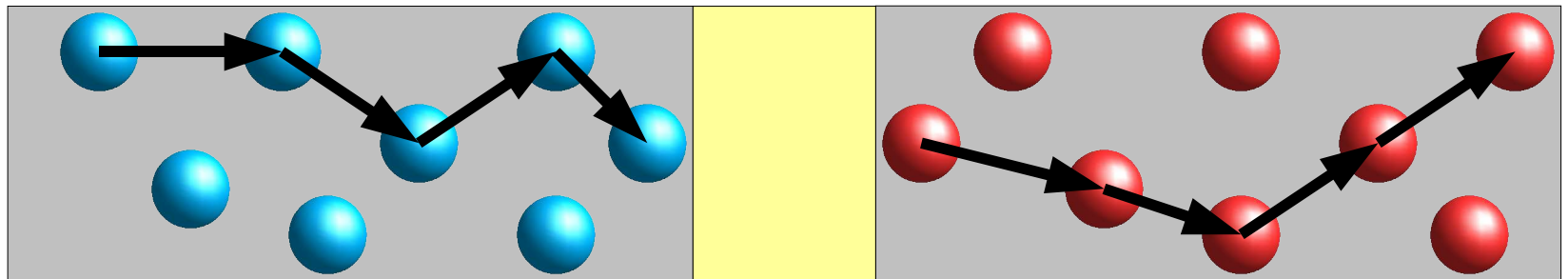
# Magnetic Tunnel Junctions

## Spin conserved!

$R_P$   
(low)



$R_{AP}$   
(high)

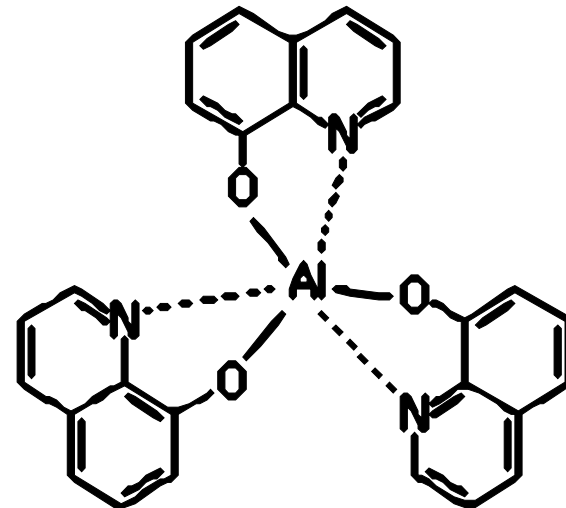


$$\text{TMR} \equiv \frac{R_{AP} - R_P}{R_P}$$

# ...Organic Barrier

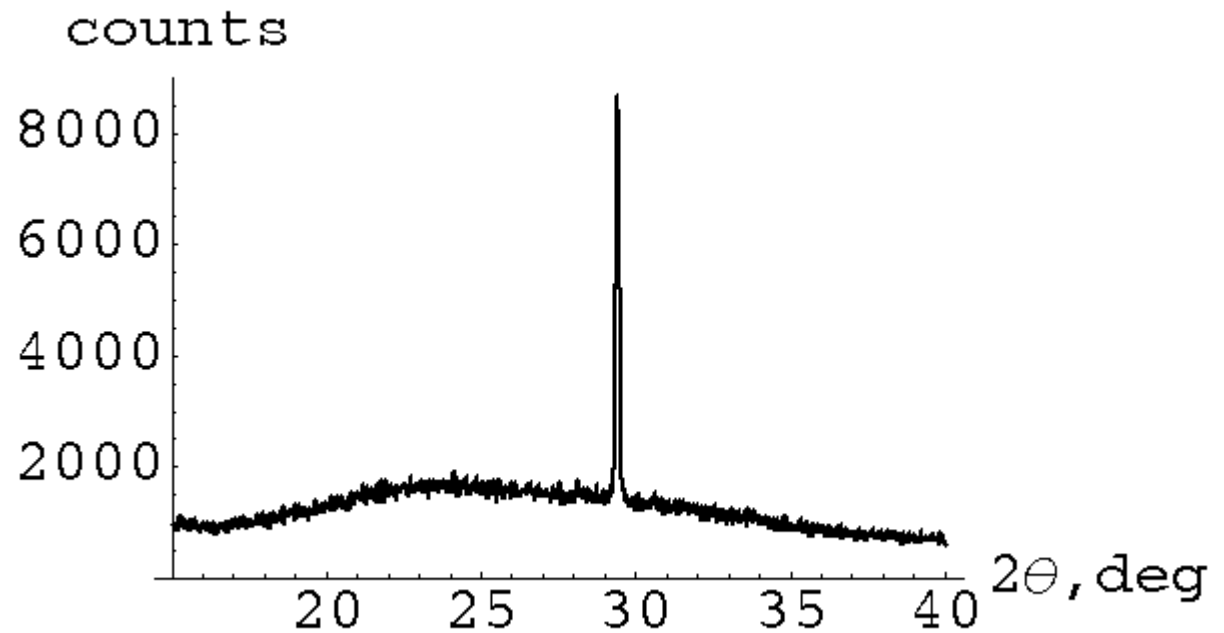
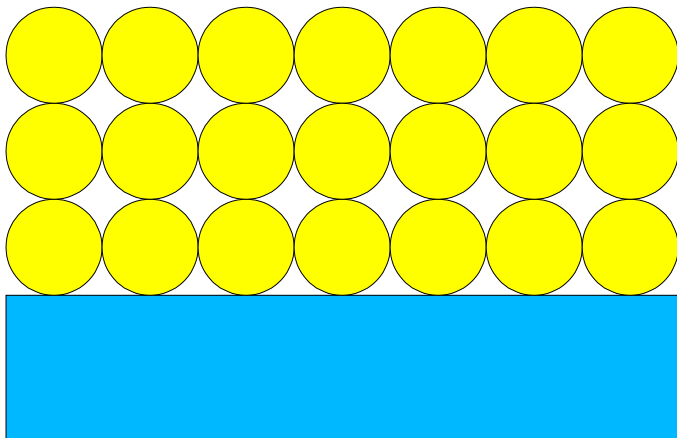
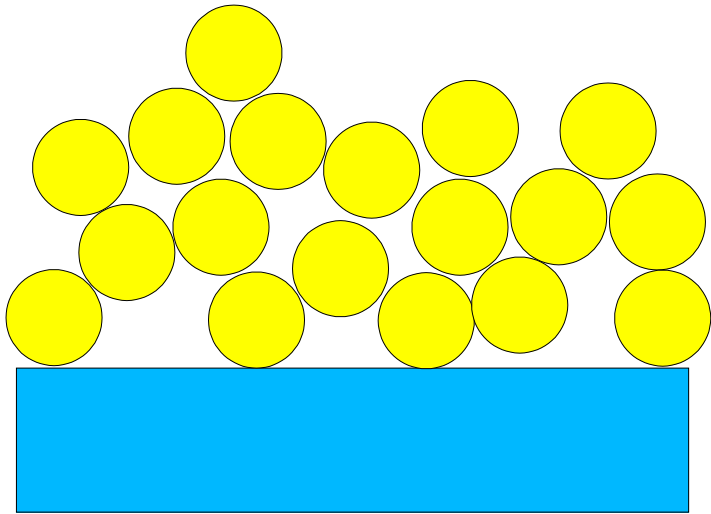
8-hydroxyquinoline aluminum  
(Alq<sub>3</sub>)

- Yellow powder
- Photoluminescent
- About 1 nm
- Organic!



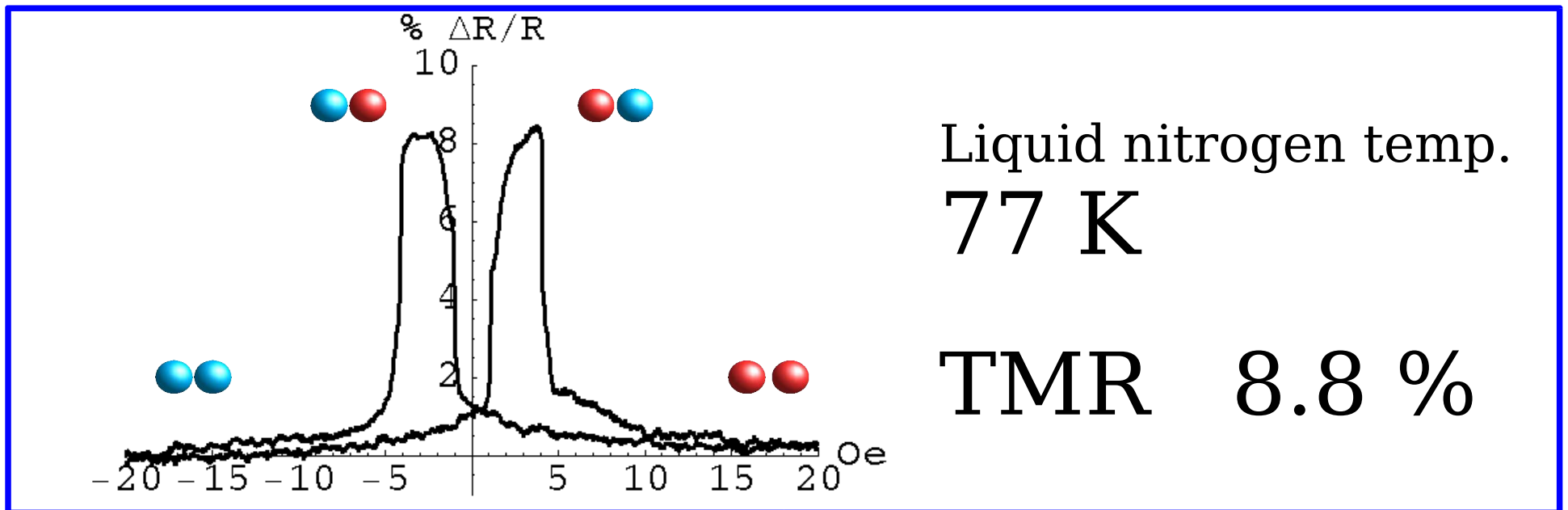
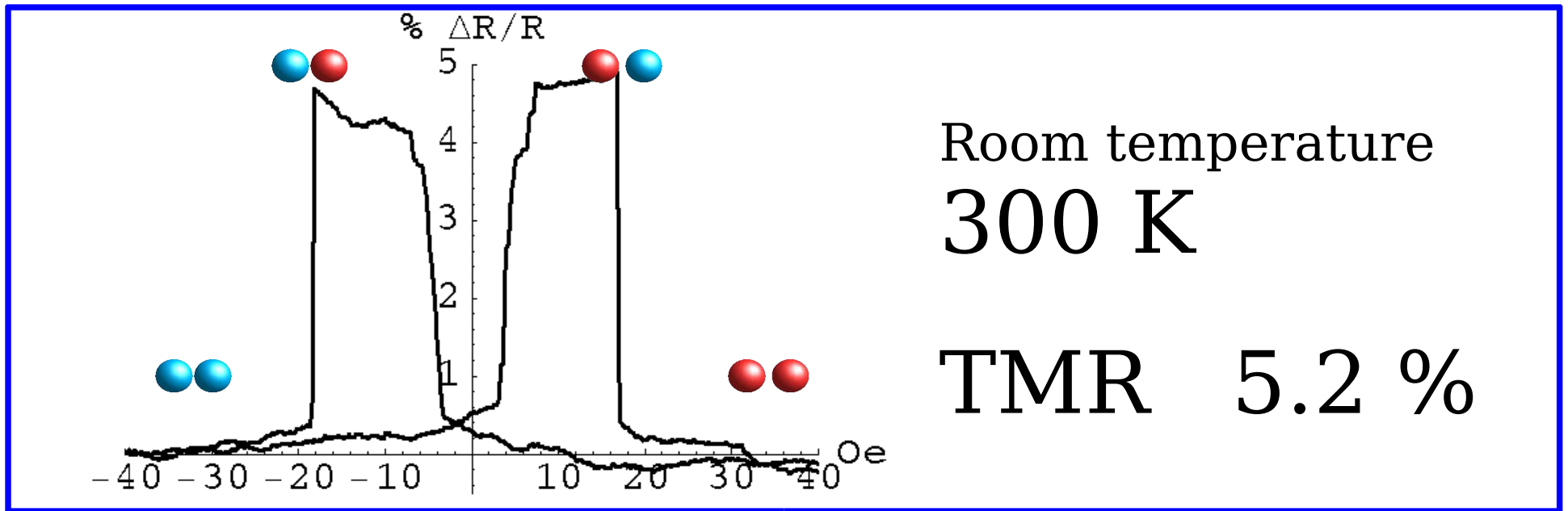
# Crystal Structure

## X-Ray diffraction



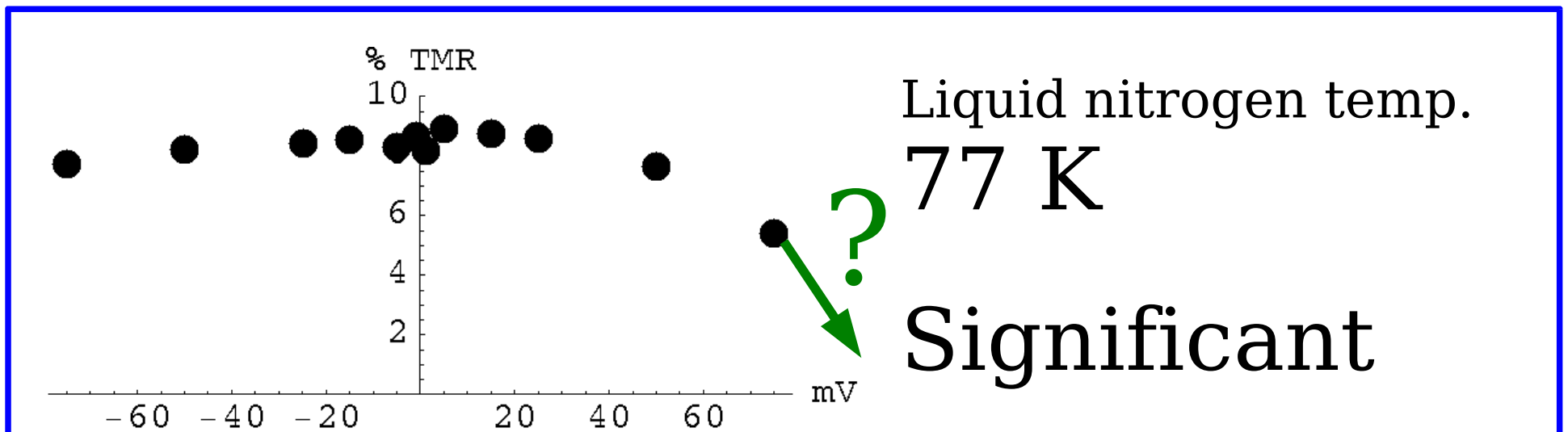
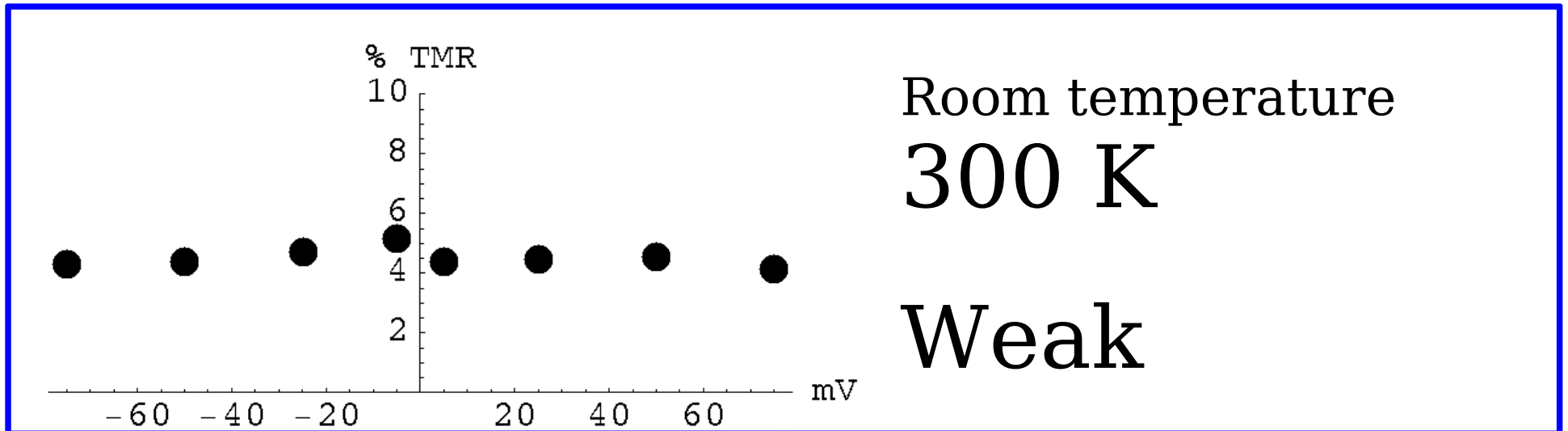
# TMR loops

$$\text{TMR} \equiv \frac{R_{\text{AP}} - R_{\text{P}}}{R_{\text{P}}}$$





# Bias-polarisation dependence



# Conclusion

- Good crystalline structure when grown
- True tunneling achieved in  $\text{Alq}_3$
- TMR measured
  - Loops observed
  - Value of a few percent
  - Voltage direction depend

# Future work

- Higher voltages, lower temperatures
- Light-dependent spin tunneling:  
Opto-spintronics!

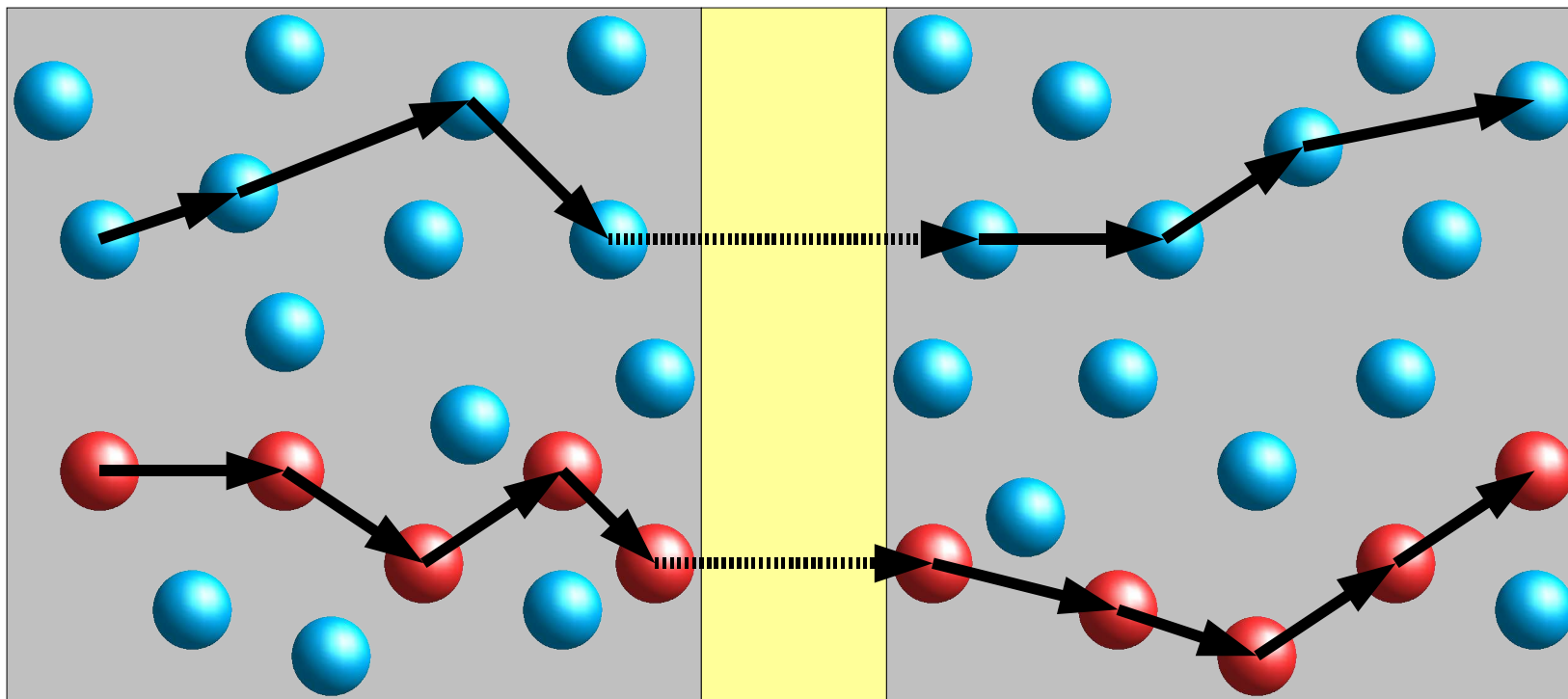
# Applications

- Magnetic computer memories:  
MRAMs

# Acknowledgements

- **Dr. Jagadeesh S. Moodera**
  - Dr. Patrick R. LeClair
  - Tiffany Santos
  - Dr. John Philips
  
  - Dr. Jenny Sendova
  - Szymon Acedanski
  - TAs, Nobodies, etc.
  
  - The Audience
- Ryszard Rakowski
  - CEE
  - MIT

# Polarisation

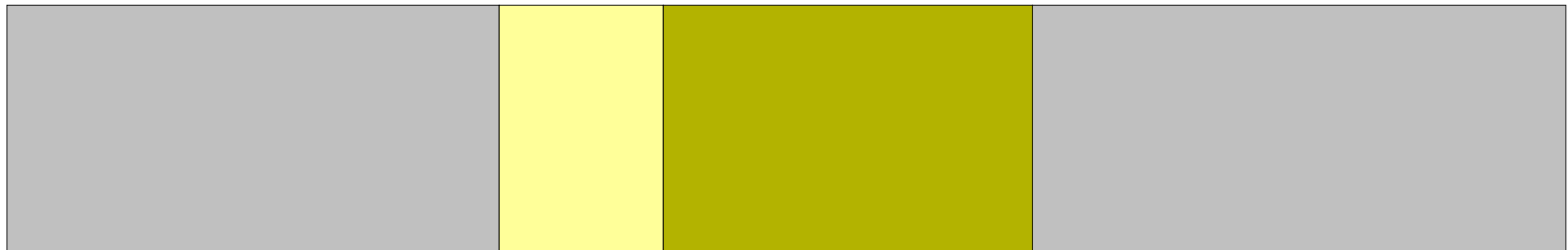


# Our MTJ

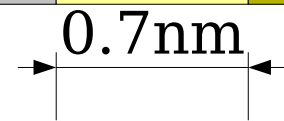
Insulator 2

( $Alq_3$ )

4 nm



Metal 1  
(Co)



Insulator 1  
( $Al_2O_3$ )

Metal 2  
(Py – 80% Fe 20% Ni)