KITAEV MATERIAL

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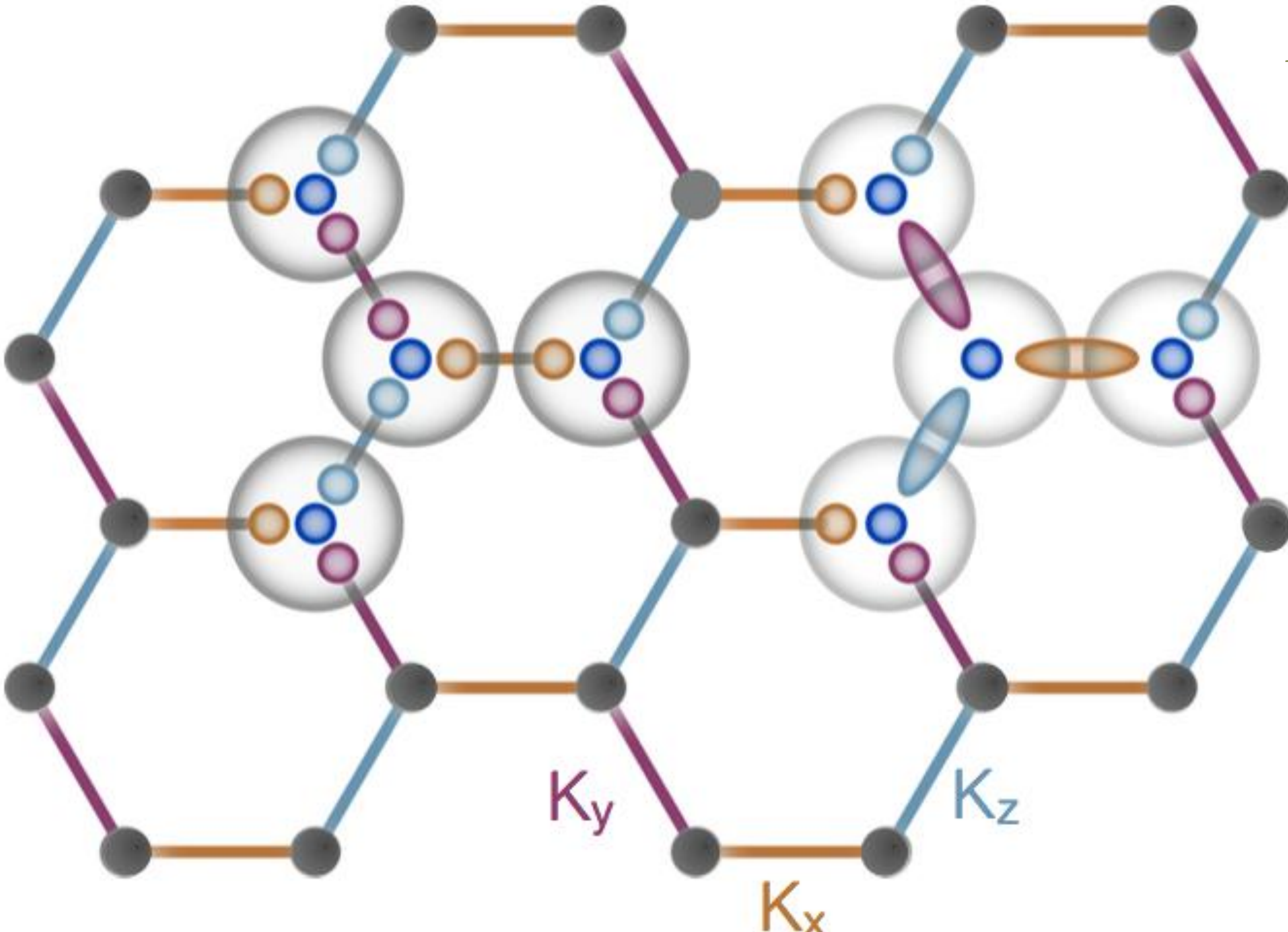
presented by Fangdi Wen

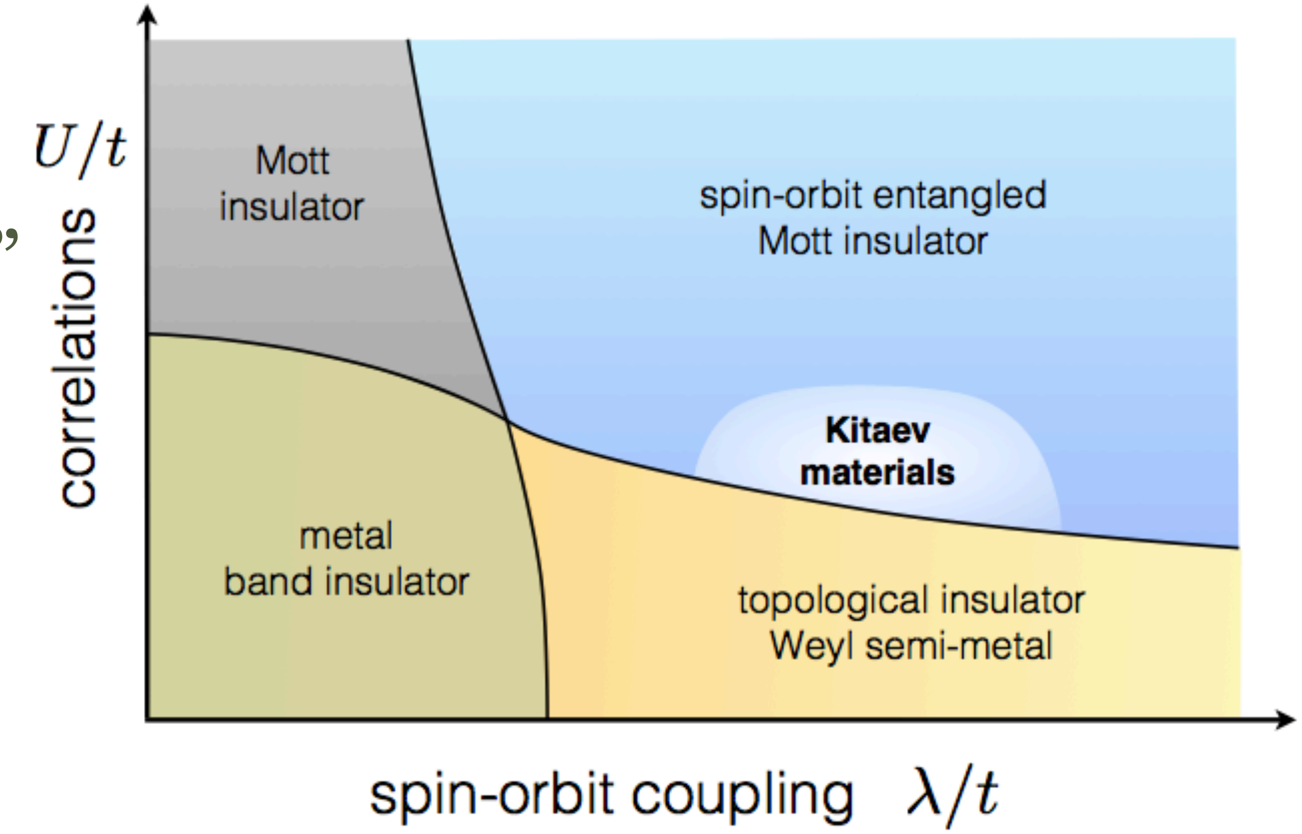


For Prof. Jak Chakhalian's Solid State Physics

arXiv:1701.07056v1 [cond-mat.str-el] 24 Jan 2017

What is Kitaev Material?

"spin-orbit assisted Mott insulators "



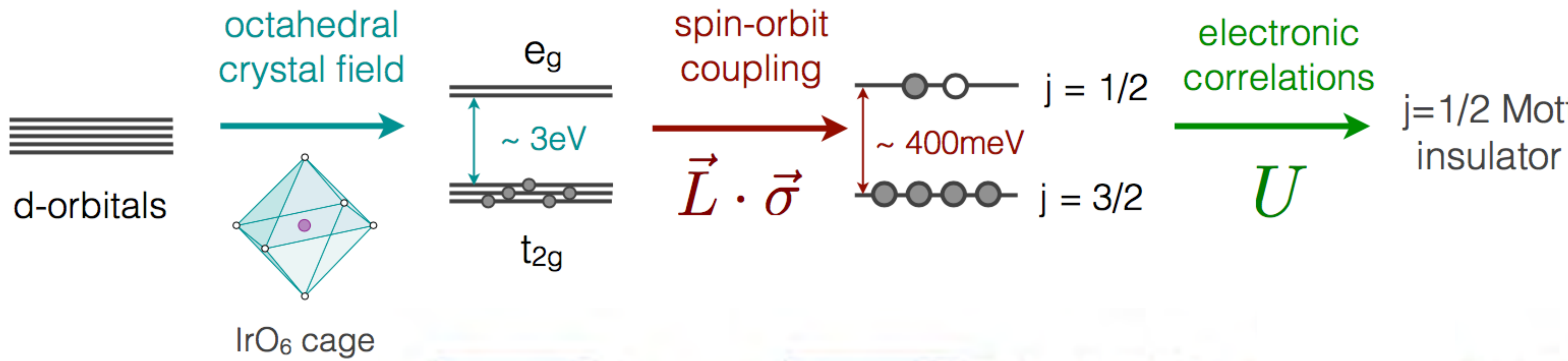
- What makes it Mott Insulator?
- What gives it high magnetic frustration? (Spin Liquids?)
- What is unusual about it?

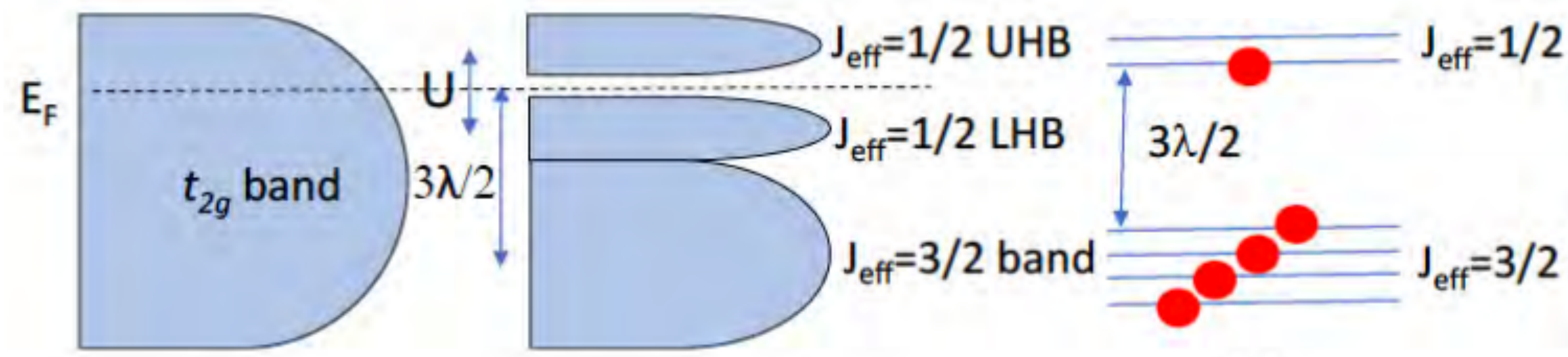
W. Witczak-Krempa, G. Chen, Y. B. Kim, and L. Balents, Annual Review of Condensed Matter Physics 5, 57 (2014)

Spin-Orbit Coupling

Z+, large radius (large band width)

SOC+, suppress band width





Large band width—
U don't split the band

Small band width—
U might split the gap
Mott Gap

arXiv:1704.06007 [cond-mat.str-el] arXiv:1701.07056v1 [cond-mat.str-el] 24 Jan 2017

Electronic correlation

$$-\frac{8t^2 J_H}{3U^2} S_1^\gamma S_2^\gamma$$

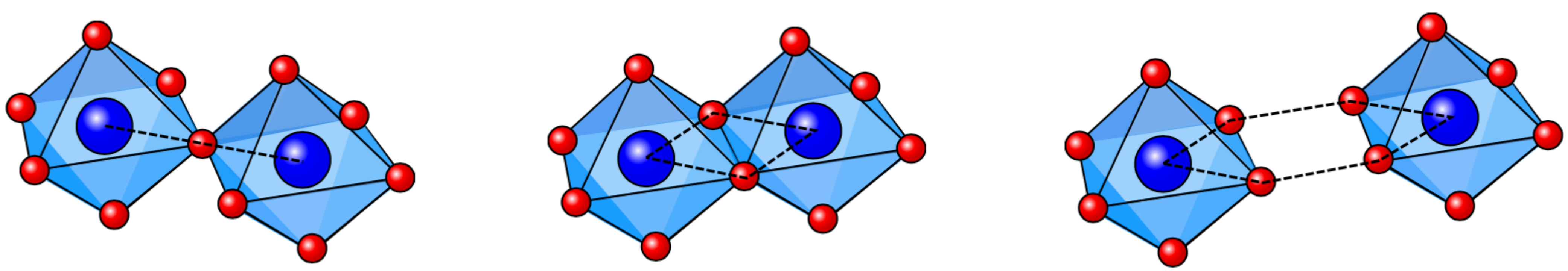
Two exchange paths

↓

Interference of wave function

↓

bond-directional coupling (Kitaev couplings)



Ising-like coupling

arXiv:1701.07056v1 [cond-mat.str-el] 24 Jan 2017

Exchange frustration

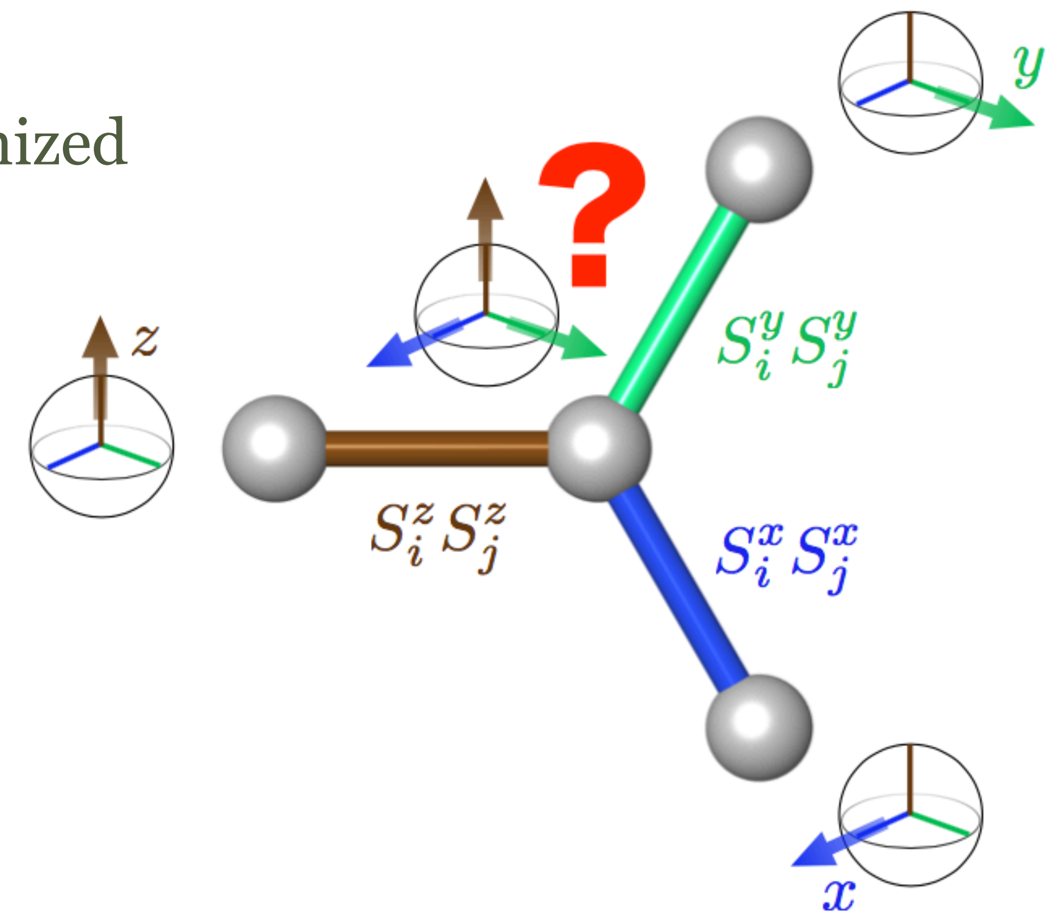
$$H = -\sum_{\gamma-\text{bonds}} J\,\mathbf{S}_i\mathbf{S}_j + K\; S_i^\gamma S_j^\gamma + \Gamma\left(S_i^\alpha S_j^\beta + S_i^\beta S_j^\alpha\right)$$

strong exchange frustration:

these interactions cannot be simultaneously minimized

↓

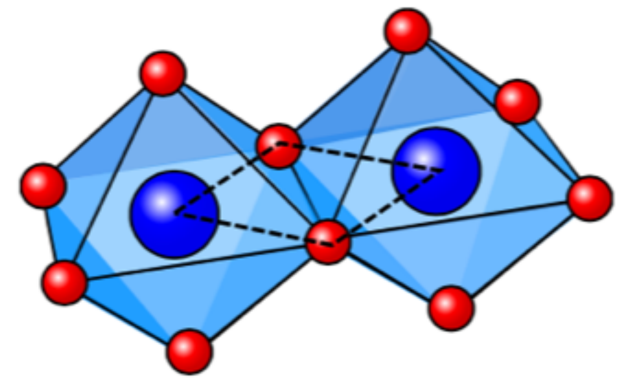
ground-state entropy



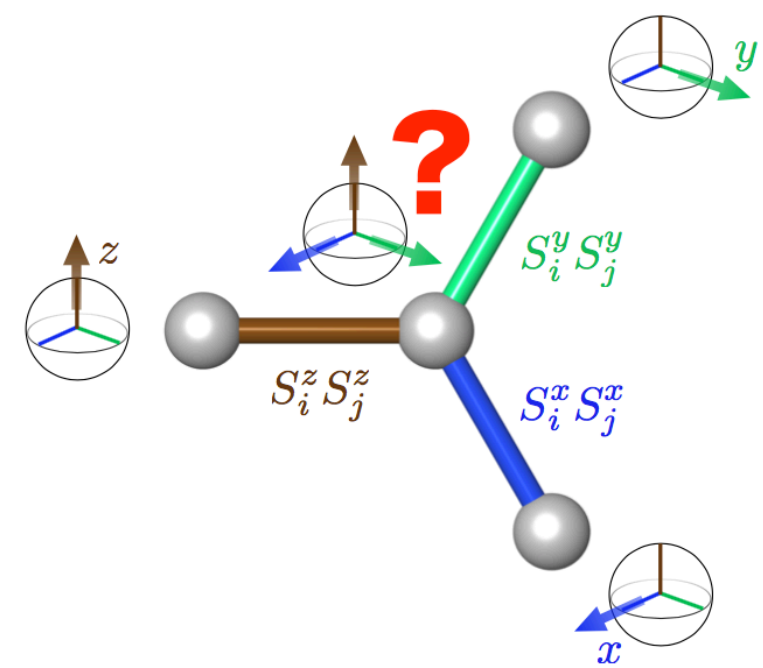
Frustration * 2 ~ Quantum Spin Liquid!

Why is Kitaev materials special?

Ferromagnetic



Magnetic anisotropy



(Majorana Fermions)

Possible Kitaev materials:

Hexagonal: Na_2IrO_3

Triangle: $Ba_3Ir_{(2-x)}Ti_xO_9$

3D: Theoretical prediction

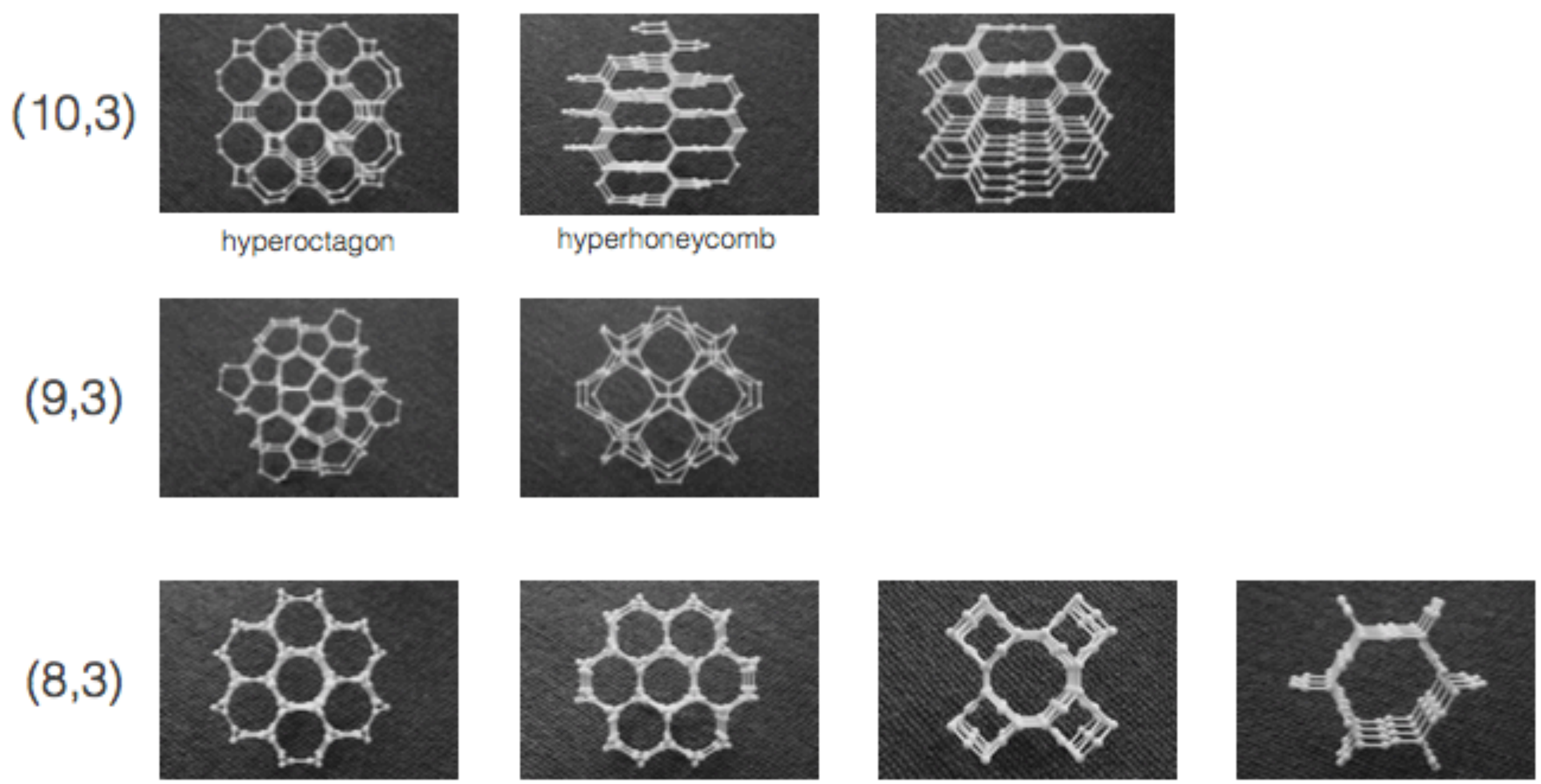
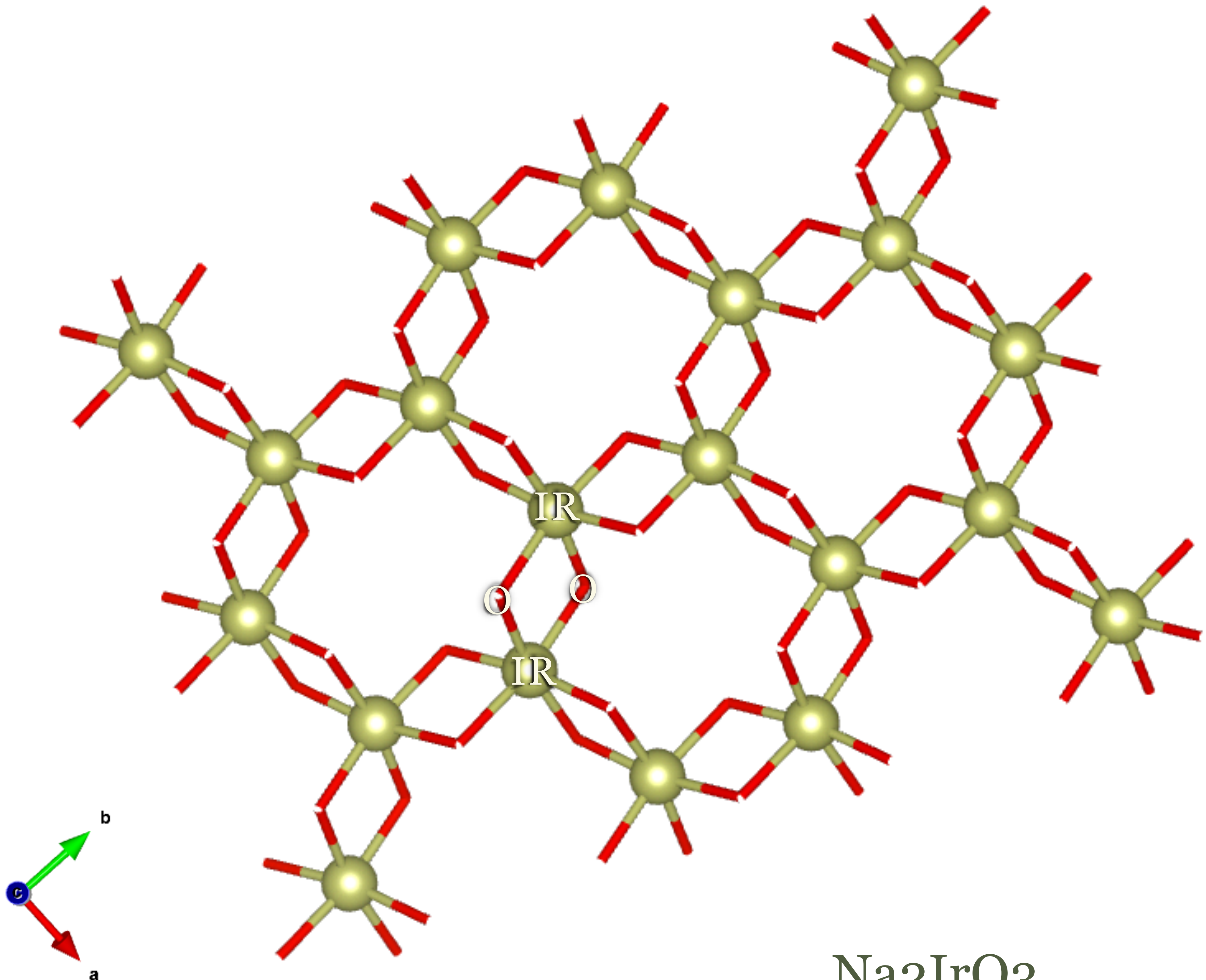


Fig. 14: *Illustration of the elementary tricoordinated lattices by photographs of 3D printed models. Further information on these lattices is provided in Table 1.*

Example:



Na2IrO3

Summery | Kitaev Materials

a family of spin-orbit assisted j=1/2 Mott insulators

bond-directional exchange induces frustration

unconventional forms of magnetism