

Requirements for Zero-Gap States in Organic Conductors

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Recently, massless Dirac fermions in monolayer graphene have attracted a great deal of attention due to the anomalous quantum Hall effect with a phase shift corresponding to Berry's phase, extremely high mobility, and other intriguing properties. It has been recently found that an organic conductor α -(BEDT-TTF)₂I₃ has a similar zero-gap state under pressure [1]. Here, requirements for zero-gap states are discussed from the viewpoint of the tight-binding energy band. From the analytical solutions of the energy bands as well as the numerical energy-band calculations, most systems with two molecules in a unit cell do not have a contact point between the upper most and the second bands, whereas most systems with four molecules have a contact point. These systems usually have semi-metallic Fermi surface, but in the presence of non-stripe charge order [2], these compounds afford the actual zero-gap state very easily. Presently, α -(BEDT-TTF)₂I₃ seems to be the only compound that fulfills all these requirements, but other possibilities are discussed.

[1] N. Tajima, *J. Phys. Soc. Jpn.* **75**, 051010 (2006). A. Kobayashi, *Sci. Tech. Adv. Mater.* **10**, 024309 (2009). [2] T. Mori, *J. Mater. Chem.* **17**, 4343 (2007).

