The electronic structure of quasicrystals

S. R. Barman
UGC-DAE Consortium for Scientific Research,
Khandwa Road, Indore.

Abstract

Quasicrystals have fascinated scientists from the time of their discovery. It is still unclear why nature prefers the quasicrystalline symmetry at some parts of the phase diagram. Quasicrystals have forbidden symmetry and exhibit remarkable physical properties such as high resistivity and low thermal conductivity. On the basis of theoretical calculations, it was proposed that the stability of quasicrystals arises from a Brillouin zone-Fermi surface interaction that induces a pseudogap at the Fermi level. Only recently, using hard x-ray photoelectron spectroscopy, we have established the existence of a pseudogap in a range of quasicrystalline solids such as icosahedral (*i*) Al-Pd-Mn, Al-Cu-Fe, Zn-Mg-Y, and Zn-Mg-Dy.[i,2] In contrast to *i*-Al-Pd-Mn, the pseudogap is fully formed in *i*-Al-Cu-Fe, which is in agreement with the transport studies that have shown that i-Al-Cu-Fe is close to a metal-insulator phase boundary. In order to probe the pseudogap in the unoccupied density of states, we have fabricated an inverse photoemission spectrometer.[3] The surprising finding is that the pseudogap in Al-Pd-Mn is more pronounced above the Fermi level.[4] Although quasicrystal have been found in ternary and binary alloys, an elemental quasicrystal has not been discovered so far. In the last part of the talk, I will discuss our efforts to find an elemental quasicrystal through templated growth.[5]

References:

[1]. J. Nayak, M. Maniraj, A. Rai, S. Singh, P. Rajput, A. Gloskovskii, J. Zegenhagen, D. L. Schlagel, T. A. Lograsso, K. Horn, and S. R. Barman, Phys. Rev. Lett. 109, 216403 (2012).

[2.] J. Nayak, M. Maniraj, A. Gloskovskii, M. Krajčí, S. Sebastian, I. R. Fisher, K. Horn, and S. R. Barman, Phys. Rev. B 91, 235116 (2015).

[3] S. Banik, A. K. Shukla, and S. R. Barman**,** Rev. Sci. Instrum. 76, 066102 (2005); A. K. Shukla, S. Banik and S. R. Barman, Current Science 90, 490 (2006).

[4] M. Maniraj, Abhishek Rai, and S. R. Barman, M. Krajčí, D. L. Schlagel, T. A. Lograsso, K. Horn, Phys. Rev. B 90, 115409 (2014).

[5] A. K. Shukla, R. S. Dhaka, S. W. D'Souza, Sanjay Singh, K. Horn, D. Wu, T. A. Lograsso, M. Krajčí, J. Hafner, and S. R. Barman, Phys. Rev. B 79, 134206 (2009); A. K. Shukla, R. S. Dhaka, S. W. D'Souza, M. Maniraj, S. R. Barman, K. Horn, Ph. Ebert, K. Urban, D. Wu and T. A. Lograsso, J. Phys. Condens. Matter 21, 405005 (2009).

i