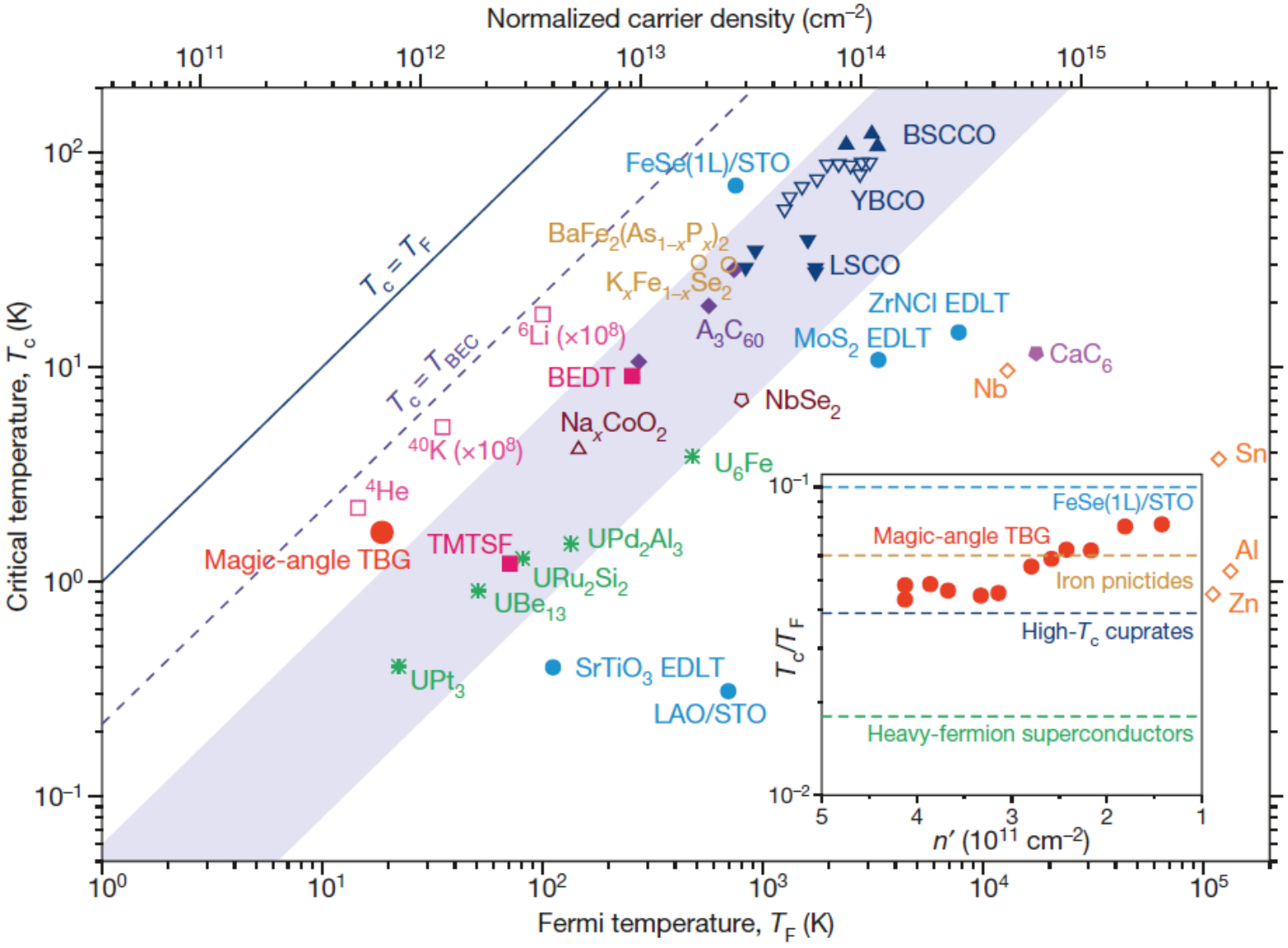
Strong Electron-Electron Correlations and Superconductivity



High values of T_c/T_F imply strong correlations

- Heavy-fermion superconductors
- Cuprates
- Iron pnictides
- Conventional superconductors
- BEC in atoms
- Two-dimensional materials
- Organic superconductors
- A_3C_{60}
- $NbSe_2$
- Na_xCoO_2
- CaC_6
- Magic-angle TBG

Yuan Cao, Valla Fatemi, Shiang Fang, Kenji Watanabe, Takashi Taniguchi, Efthimios Kaxiras, and Pablo Jarillo-Herrero, "Unconventional superconductivity in magic-angle graphene superlattices," Nature **556 (7699), 43-50 (2018).**

Figure 6 | Superconductivity in the strong-coupling limit. Logarithmic plot of critical temperature T_c versus Fermi temperature T_F for various superconductors[36]. The top axis is the corresponding two-dimensional carrier density n_{2D} for two-dimensional materials or $n_{3D}^{2/3}$ for three-dimensional materials, normalized by the effective mass m^*/m_e and the Fermi surface degeneracy g (and a constant factor of 1/1.52 for the three-dimensional density). Two-dimensional superconductors are represented by filled circles; other symbols represent three-dimensional (but potentially two-dimensional-like) superconductors. For comparison, we also plot $T_{BEC} = 1.04\hbar n_{3D}/m^*$ for a three-dimensional bosonic gas (dashed line). Bose–Einstein condensation temperatures in ^{4}He, paired fermionic ^{40}K and paired fermionic ^{6}Li are shown as open pink squares[36,44] (T_c and T_F have both been multiplied by 10^8 for ^{40}K and ^{6}Li). The point for magic-angle TBG (large red filled circle) is calculated from the two-dimensional density and the effective mass obtained from quantum oscillations (Fig. 5d, e) at the optimal doping ($n_{2D} = 1.5 \times 10^{11}$ cm^{-2} and $m^* = 0.2m_e$), using $g = 1$ to account for the halved degeneracy. Data for other materials are from refs 36,45–54. The blue shaded region is the approximate region in which almost all known unconventional superconductors lie. The inset shows the variation in T_c/T_F as a function of doping n' for magic-angle TBG (red filled circles). The horizontal dashed lines are the approximate T_c/T_F values of the corresponding material. YBCO, $YBa_2Cu_3O_{7-\delta}$; LSCO, $La_{2-x}Sr_xCuO_4$; BSCCO, $Bi_2Sr_2Ca_2Cu_3O_y$; LAO, $LaAlO_3$; STO, $SrTiO_3$; 1L, single layer; EDLT, electric double-layer transistor; BEDT, bisethylenedithiol; TMTSF, tetramethyltetraselenafulvalene.

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