

Emergent Dynamical Kondo Coherence and Competing Magnetic Order in a Correlated Kagome Flat-Band Metal CsCr₆Sb₆

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Correlated kagome metals host unique electronic states that enable exotic quantum phenomena. In the recently emerged CsCr₆Sb₆, these manifest through Kondo behavior from localized Cr-3d electrons and unprecedented band flattening near the Fermi level. Yet the intricate interplay among Kondo screening, magnetic frustration, and electronic correlations remains poorly understood—a fundamental gap we address through multifaceted experimental and theoretical approaches. Our angle-resolved photoemission spectroscopy measurements reveal electronic correlation-renormalized flat bands, and our muon spin relaxation study detects short-range magnetic order at $T_N \sim 80$ K. Complementing these findings, density-functional theory and dynamical mean-field theory calculations identify a coherent-incoherent crossover at T_N , with a remarkable restoration of coherence accompanying local moment suppression—an anomalous hallmark of Kondo behavior. Intriguingly, despite strong interlayer antiferromagnetic coupling, the system evades long-range magnetic order due to competing magnetic configurations separated by sub-meV energy differences. These insights establish CsCr₆Sb₆ as a prototypical platform for investigating dynamical Kondo screening in correlated flat-band systems, opening new avenues to study flat-band physics and frustrated magnetism in correlated kagome lattices.

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Introduction—Kagome lattices have emerged as a quintessential platform for discovering novel correlated topological states [1–22]. In their Mott-insulating phase, geometrically frustrated $S = 1/2$ moments give rise to quantum spin liquids featuring fractionalized excitations and emergent gauge fields [8,9]. When metallized, the unique geometry of the lattice induces destructive interference in nearest-neighbor hopping, producing a remarkable

electronic spectrum characterized by Dirac nodes, van Hove singularities (vHSs), and correlation-narrowed flat bands. These distinctive features, coupled with nontrivial Berry curvature, place kagome metals at the frontier where strong correlations meet topological physics, opening new avenues for discovering exotic quantum phases.

The AV₃Sb₅ compounds ($A = \text{K, Rb, Cs}$) exemplify conventional kagome metals, featuring delocalized electrons from nonmagnetic V ions that form quasi-two-dimensional (2D) band structures tunable near vHS [1–3]. A fundamentally different scenario emerges when localized 4f/5f electrons prevail, enhancing on site Coulomb repulsion (U) and giving rise to Kondo-lattice physics—where conduction electrons screen local moments below a characteristic temperature scale [23–25]. While historically

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associated with $4f/5f$ systems, Kondo phenomena have recently been identified in $3d$ transition-metal oxides and van der Waals materials [26–30], prompting a reevaluation of the essential criteria for Kondo screening.

The manifestation of electronic correlations in kagome systems reveals remarkable diversity: Nb_3Cl_8 transforms into a Mott insulator with well-defined Hubbard bands [31,32], while Ni_3In and pressurized CsCr_3Sb_5 display strange-metal behavior mediated by flat-band Kondo effects without local moments [33–36]. The incipient flat band of CsCr_3Sb_5 [~ 80 meV below the Fermi level (E_F)] supports Hund’s metallicity and antiferromagnetic (AFM) fluctuations, contrasting sharply with the Kondo insulating gap observed in the newly discovered CsCr_6Sb_6 [37]. The latter system provides an unprecedented insight into the competition between Kondo screening and short-range magnetic order. Its ultraflat band (band width ~ 40 meV) pinned at E_F causes extreme electron localization, while spectroscopic evidence reveals a 10–15 meV Kondo gap—a hallmark of coherent moment screening. Most notably, the absence of long-range order despite strong local correlations suggests a quantum-critical regime where short-range magnetism and Kondo hybridization remain in a delicate balance. This makes CsCr_6Sb_6 an exceptional platform for investigating (1) Kondo coherence mechanisms in frustrated flat-band systems; (2) quantum fluctuation-mediated suppression of magnetic order in $3d$ -electron materials; and (3) short-range correlation effects on non-Fermi-liquid transport—key characteristics of strongly correlated quantum matter.

Our integrated experimental and theoretical investigation of CsCr_6Sb_6 clarifies its unique magnetic and electronic ground state. Magnetotransport and magnetization measurements confirm hallmark heavy-fermion behavior with pronounced Kondo scattering at low temperatures, characteristic of correlated electrons in the frustrated kagome lattice. High-resolution angle-resolved photoemission spectroscopy (ARPES) directly visualizes an isolated, nearly dispersionless flat band pinned at E_F , providing a clear momentum-space signature of electronic localization. Intriguingly, zero-field muon spin relaxation (ZF- μ SR) reveals only short-range magnetic order down to the lowest temperatures, in contrast to the coherent Fermi-liquid state expected in fully screened Kondo lattices. This observation is supported by combined density-functional theory (DFT) and dynamical mean-field theory (DMFT) calculations, which show that strong electronic correlations not only renormalize the flat band and enhance quasiparticle effective mass but also sustain short-range spin correlations, thereby suppressing long-range magnetic order. Our findings establish CsCr_6Sb_6 as a model system for studying the interplay between geometric frustration, flat-band physics, and incomplete Kondo screening.

The details for single crystal growth, quality examinations, energy dispersive spectroscopy characterizations,

magnetotransport, ARPES, and ZF- μ SR measurements of the Kondo behavior in CsCr_6Sb_6 are presented in the Supplemental Material which includes Figs. S1–S10, Tables S1, and S2 [38] and Refs. [13,37].

Results and discussions—In contrast to CsCr_3Sb_5 , which crystallizes in a hexagonal structure (space group: $P6/mmm$) with alternating 2D kagome Cr_3Sb_5 planes and Cs layers, CsCr_6Sb_6 adopts a rhombohedral lattice (space group: $R\bar{3}m$) featuring a double-layer kagome network (Cr_6Sb_6) stacked in an ABC sequence and intercalated by Cs spacers. As shown in Figs. 1(a) and 1(b), the Cr-Sb layers exhibit a lateral shift of $(1/3a, -1/3b)$ along the c axis, generating a geometrically frustrated lattice. This architecture hosts correlated $3d$ electrons that drive the observed Kondo phenomenology. The temperature-dependent resistivity $\rho(T)$ [Fig. 1(c)] reveals a metallic baseline ($d\rho/dT > 0$) at high temperatures and exhibits two anomalies: (i) a resistivity minimum at $T_N = 80$ K, signaling the onset of short-range magnetic order and (ii) a pronounced low-temperature upturn until $T_K (\sim 15$ K) indicative of Kondo scattering. This upturn is mirrored in the magnetic susceptibility $\chi(T)$ [Fig. 1(d)], which transitions from Curie-Weiss behavior at high temperatures to enhanced spin correlations below T_N . We determine the effective magnetic moment and Weiss temperature through a Curie-Weiss fit to the bulk susceptibility data (Fig. S3 [38]). The extracted effective moment of $1.86 \mu_B/\text{Cr}$ and the large negative Weiss temperature ($\Theta_P = -1902$ K) point to strong AFM coupling between local Cr^{3+} moments, mediated by conduction electrons via the Ruderman-Kittel-Kasuya-Yosida interaction in the kagome lattice. The low-temperature resistivity is quantitatively described by the phenomenological model $\rho(T) = aT^5 + c\rho_0 - c\rho_1 \ln T$ [26], where aT^5 denotes unusual phonon resistivity, and the $-\ln T$ term reflects spin-flip scattering between localized Cr- $3d$ moments and itinerant electrons. Below the Kondo temperature $T_K \sim 15$ K, this logarithmic divergence softens as partial Kondo singlet formation reduces scattering—a hallmark of heavy-fermion behavior [27]. Parallels emerge with the d -electron Kondo system Ni_3In [33], where frustration and flat bands similarly promote localized moments. In CsCr_6Sb_6 , the flat band of the kagome lattice (pinned near the E_F by strong correlations) localizes Cr- $3d$ electrons, providing a platform to explore Kondo physics without f -electron involvement.

The interplay of Kondo and magnetic order is further evidenced in magnetoresistance [MR, Fig. 1(e)]. For $T > T_N$, a weak positive MR arises from the enhanced effective lattice scattering due to the Lorentz force. Below T_N , the development of short-range magnetic order by correlations reduces spin-disorder scattering, leading to a crossover to negative magnetoresistance as the applied field aligns the local moments. This negative magnetoresistance reaches its maximum amplitude near T_K , where the competition between Kondo screening and field-induced spin polarization is most pronounced. When the temperature

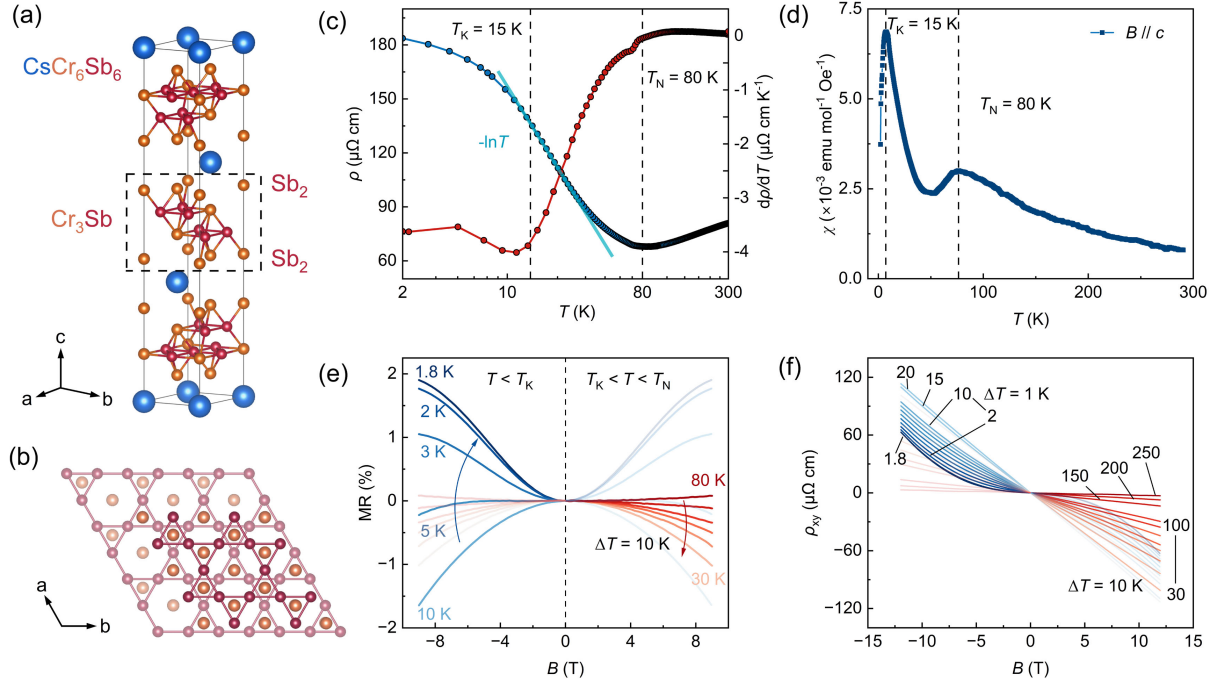


FIG. 1. (a) Side view of the crystal structure of CsCr_6Sb_6 showing the layered arrangement along the c axis. (b) Top view of the double kagome network in the plane, highlighting the geometrically frustrated Cr sublattice. (c) In plane $\rho(T)$ (blue) and its derivative $d\rho/dT$ (red). The sharp change in $d\rho/dT$ at $T_N = 80$ K marks the onset of short-range magnetic order. The cyan curve shows the characteristic $-\ln T$ dependence expected for Kondo scattering, with deviation below $T_K = 15$ K indicating partial formation of Kondo singlets. (d) $\chi(T)$ measured at $H = 2$ kOe ($H//c$). The magnetic susceptibility signal reveals (i) Curie-Weiss behavior above T_N , (ii) enhanced spin correlations below T_N , and (iii) suppressed magnetism after the formation of Kondo singlets. (e) MR and (f) Hall resistivity at selected temperatures ($H//c$ up to 12 T). The MR crossover from positive to negative below T_N signifies the competition between Kondo screening and field-induced spin polarization. Below T_K , the nonlinear Hall response reveals multiband behavior postrenormalization, while its strong temperature dependence underscores carrier density tuning by electronic correlations.

decreases below T_K , a second crossover from negative to positive MR appears, and the formation of Kondo singlets diminishes the local moment and screens the conducting electrons from scattering. At $T \ll T_K$, the increase in high-field MR becomes gradual once the Zeeman energy exceeds $k_B T_K$ (k_B is the Boltzmann constant), consistent with the magnetic destruction of the Kondo singlets [28]. As evidenced in Fig. 1(f), the Hall response displays linear field dependence above T_K , with the negative Hall coefficient R_H signifying dominant electron-type carriers in a single-band regime. Upon cooling below T_K , electronic correlations induce significant band renormalization, driving the system into a multiband phase. This transition manifests as pronounced nonlinearity in the Hall signals, which are quantitatively described by a two-carrier model (see the Supplemental Material, Sec. C, including Figs. S5–S8 and Table S1 [38], and the detailed analysis). The Hall effect measurements reveal a carrier density $n \sim 10^{19} \text{ cm}^{-3}$ at low temperatures, 2 orders of magnitude lower than in V-based kagome metals (e.g., CsV_6Sb_6 , $n \sim 10^{21} \text{ cm}^{-3}$ [29]). This depressed n , comparable to low-carrier-density Kondo lattice $\text{Pr}_2\text{Ir}_2\text{O}_7$ [30], underscores the dominance of localized $3d$ moments in charge transport. The correlation-driven band renormalization has been verified through

experiments and calculations in Figs. 2 and 4, respectively. The above characterizations indicate that CsCr_6Sb_6 epitomizes a d -electron Kondo lattice where geometric frustration, flat-band localization, and strong correlations converge. The coexistence of short-range order ($T_N = 80$ K) and Kondo screening ($T_K = 15$ K) manifests in distinct transport and magnetic anomalies, offering a novel platform to explore flat-band physics and frustrated magnetism beyond traditional f -electron systems.

To elucidate the origin of the exotic properties of CsCr_6Sb_6 , we performed high-resolution ARPES measurements. Systematic photon-energy-dependent ARPES measurements reveal a clear k_z dispersion at a binding energy of ~ 0.5 eV, confirming the bulk nature of the observed band structure. In contrast, the near- E_F electronic states exhibit quasi-two-dimensional characteristics (Fig. S9 [38]) [53]. Figure 2(a) shows the Fermi surface mapping measured with a photon energy of $h\nu = 100$ eV in the surface Brillouin zone (perpendicular to the c axis). Multiple circular pockets are observed around the high-symmetry points $\bar{\Gamma}$ and $\bar{M}$, together with a discernible feature centered at $\bar{K}$. These features originate from the crossings of several dispersive bands with E_F , indicating a complex multiband electronic structure. The band dispersions along the

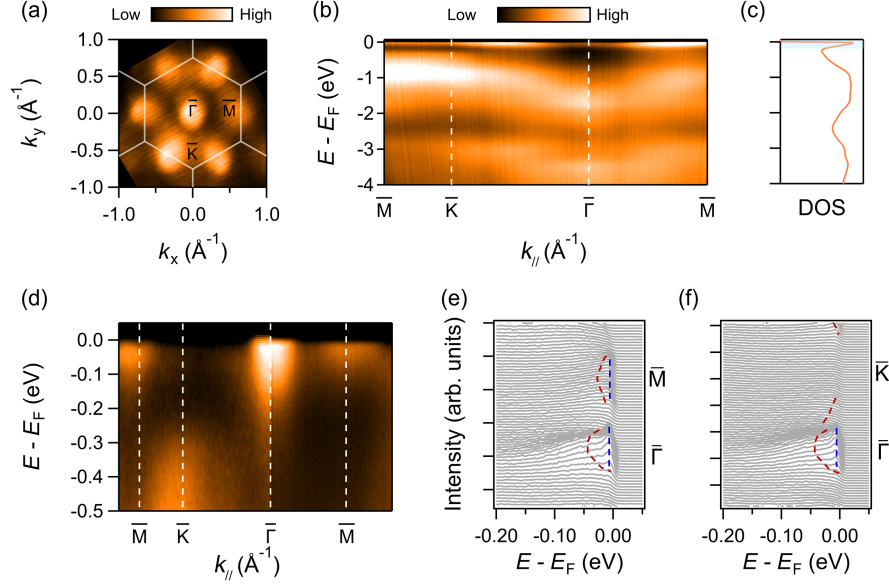


FIG. 2. (a) Fermi surface mapping of CsCr₆Sb₆ in the surface Brillouin zone, measured with $h\nu = 100$ eV (linear horizontal polarization, $T = 10$ K). (b) ARPES intensity plot along the $\bar{M}$ - $\bar{K}$ - $\bar{\Gamma}$ - $\bar{M}$ high-symmetry path ($h\nu = 30$ eV, linear horizontal polarization, $T = 10$ K). (c) Momentum-integrated DOS derived from the intensity plot (b). The shaded region highlights the flat band's dominant contribution. (d) ARPES intensity along the $\bar{M}$ - $\bar{K}$ - $\bar{\Gamma}$ - $\bar{M}$ high-symmetry path measured with higher photon energies. The spectra along $\bar{M}$ - $\bar{K}$ - $\bar{\Gamma}$ were measured with $h\nu = 66$ eV (linear horizontal polarization, $T = 15$ K), while those along $\bar{\Gamma}$ - $\bar{M}$ were measured with $h\nu = 54$ eV (linear horizontal polarization, $T = 75$ K). (e),(f) High-resolution EDCs extracted from ARPES spectra measured with $h\nu = 54$ eV at $T = 15$ K along $\bar{\Gamma}$ - $\bar{M}$ (e) and $\bar{\Gamma}$ - $\bar{K}$ (f). Red dashed curves indicate the dispersive bands, while blue dashed lines mark the flat band.

$\bar{M}$ - $\bar{K}$ - $\bar{\Gamma}$ - $\bar{M}$ high-symmetry path, measured at $h\nu = 30$ eV [Fig. 2(b)], $h\nu = 54$ eV, and $h\nu = 66$ eV [Fig. 2(d)], reveal two prominent components: a striking nondispersive flat band pinned near E_F and weakly dispersive bands that form the observed Fermi surface pockets. The exceptional uniformity of the flat band is evident from its presence throughout the Brillouin zone and from the density of states (DOS) extracted by integrating the spectral intensity [Fig. 2(c)]. The DOS exhibits a pronounced peak centered at -20 meV with a narrow energy width of approximately 200 meV. The finite width of this peak likely reflects self-energy broadening arising from strong electron correlations, providing evidence for correlation-driven band renormalization. ARPES spectra measured with higher photon energies further highlight the coexistence of dispersive bands with the flat-band feature. As shown in Fig. 2(d), distinct dispersive bands cross E_F , including two electronlike bands centered at $\bar{\Gamma}$ and $\bar{M}$, as well as a faint holelike band near $\bar{K}$. These dispersive bands give rise to the Fermi pockets centered at the high-symmetry points identified in the Fermi surface map. Photon-energy-dependent measurements confirm that the near- E_F states are quasi-two-dimensional; therefore, the different visibility of the flat and dispersive bands under low and high photon energies originates primarily from matrix element effects rather than k_z dispersion. Importantly, the coexistence and hybridization between the flat and dispersive bands in CsCr₆Sb₆ are further supported by the observation of a

flat band resonance (see Ref. [53] for details), a spectroscopic signature reflecting the intrinsic flat band nature of this material. High-resolution energy distribution curves (EDCs) in Figs. 2(e) and 2(f) clearly resolve both the dispersive bands near E_F and the coexisting flat band, whose spectral weight is enhanced through hybridization with the dispersive states—a hallmark feature of a Kondo lattice. These results position CsCr₆Sb₆ as a rare d -electron system in which flat-band physics intertwines with pronounced many-body correlations.

Representative ZF- μ SR asymmetry spectra $A(t)$ are shown in Fig. 3(a). Data collected from 2–300 K show no oscillatory components, demonstrating the absence of long-range magnetic order down to the base temperature. The spectra consist of two distinct contributions including an exponentially relaxing sample signal (characterized by the initial asymmetry A_S and the relaxation rate λ) and a temperature-independent background signal (A_{bg}) originating from muons stopped in the silver sample holder. These features are well described by the function

$$A(t) = A_S \exp(-\lambda t) + A_{bg}. \quad (1)$$

A sharp transition in the initial asymmetry A_S at $T_N \sim 80$ K (with a transition width of ~ 15 K) is revealed. The rapid suppression of A_S below T_N indicates the existence of short-range magnetic order, i.e., the magnetic moments are

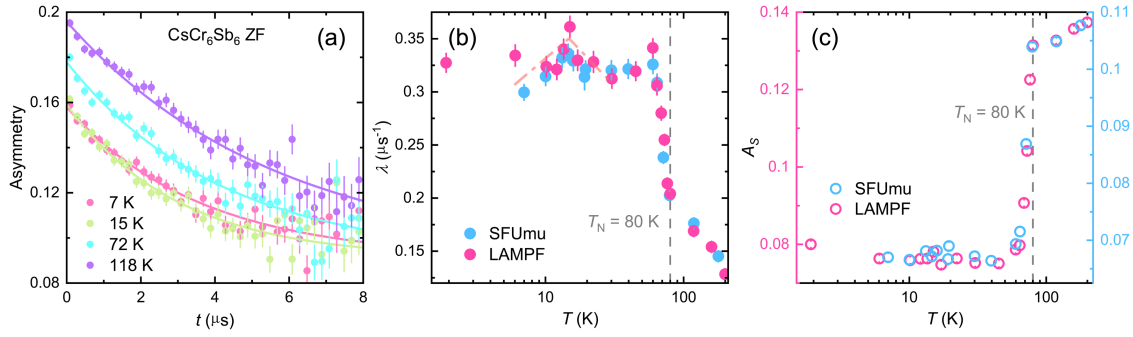


FIG. 3. (a) ZF- μ SR spectra for CsCr_6Sb_6 at representative temperatures. Solid lines: fits to Eq. (1). (b),(c) Temperature dependence of the relaxation rate λ and A_S , respectively. Blue and red circle: Data from M9 and M20 beamline, respectively.

ordered in a fraction of the sample volume where the muon spins are rapidly depolarized and do not contribute to the signal. The volume fraction of the short-range magnetic order can be estimated from the “loss” of asymmetry as $f_m = 1 - A_S(2 \text{ K})/A_S(80 \text{ K}) = 0.45(6)$. Concurrently, the relaxation rate λ exhibits a dramatic increase below T_N , signifying the strengthened local magnetism. Notably, λ displays a peak at $\sim 15 \text{ K}$, coinciding with the Kondo temperature T_K identified in transport and magnetic susceptibility measurements. These observations collectively demonstrate the coexistence of short-range magnetic order and Kondo screening in CsCr_6Sb_6 , where the competition between these phenomena manifests in the distinct temperature evolution of both A_S and λ . The μ SR results provide compelling evidence for a complex magnetic ground state characterized by nanoscale order. To further resolve the magnetic structure, we have planned inelastic neutron-scattering measurements in collaboration with specialized facilities. These experiments will directly quantify the

magnetic correlation lengths and map out the full spin excitation spectrum.

To elucidate the magnetic and electronic properties of CsCr_6Sb_6 , we complemented our experimental investigations with theoretical calculations. While the coexistence of a nearly dispersionless flat band and itinerant dispersive bands near E_F is qualitatively consistent with prior DFT results [63], our ARPES data reveal a crucial distinction: the experimental flat band shows pronounced energy renormalization and spectral broadening—features absent in the DFT band structure [37]. This deviation highlights the significant role of electron correlations in driving band renormalization. To explicitly address these correlation effects, we perform DFT + DMFT calculations. Figures 4(a)–4(d) depict the DMFT-derived electronic spectral functions under varying U and temperatures. For a modest $U = 2 \text{ eV}$ [Figs. 4(a) and 4(b)], the interacting spectra closely resemble the DFT bands. However, at a higher $U = 4 \text{ eV}$ [Fig. 4(c)], single-particle coherence is

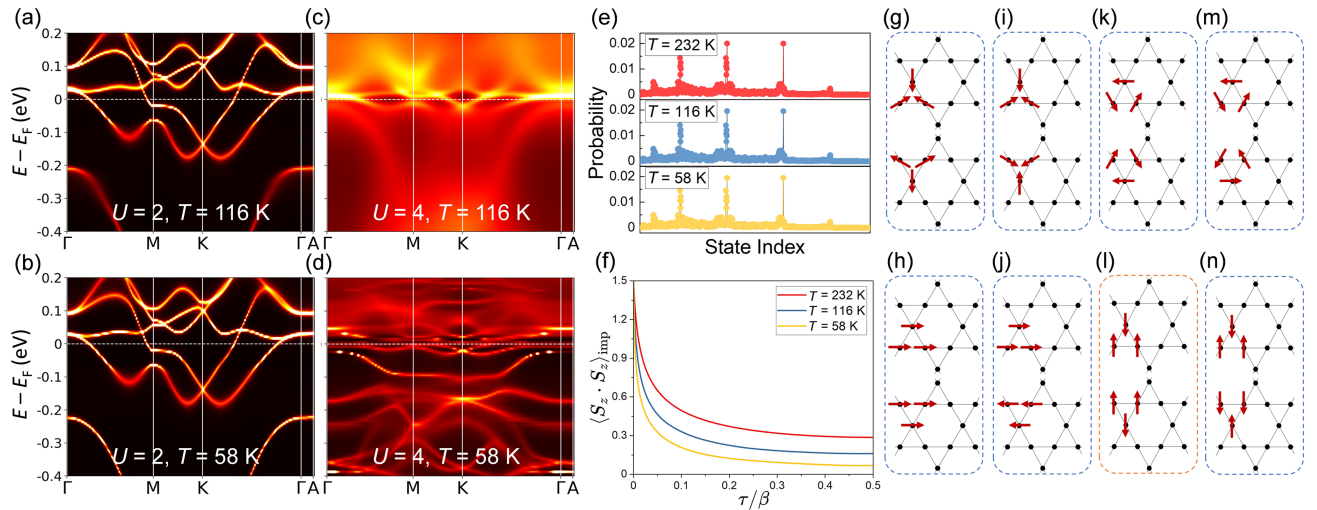


FIG. 4. (a)–(d) Interacting spectral functions as obtained by DFT + DMFT with $U = 2, 4 \text{ eV}$ and $T = 58, 116 \text{ K}$. (e) Contribution probability of the atomic states and (f) Local spin-spin susceptibilities $\langle S_z(\tau)S_z(0) \rangle$ at $T = 58, 116$, and 232 K . (g)–(n) Competing magnetic configurations with in-plane moments examined in DFT total energy calculations. Each upper and lower kagome layer denotes the two layers within a double kagome layer unit.

markedly suppressed at $T = 116$ K—a temperature that exceeds the onset of Kondo screening. Notably, in addition to this loss of coherence, the band initially located at -0.4 to -0.2 eV below E_F [Fig. 4(a)] shifts prominently toward E_F , while the dispersive band within -0.15 to 0.05 eV undergoes strong renormalization, forming a flat band at E_F in excellent agreement with our ARPES data. The DFT + DMFT calculations capture two key characteristics: (i) the renormalization and narrowing of the bandwidth and (ii) the emergence of coherent quasiparticle states near E_F while spectral weight away from E_F becomes increasingly incoherent, both of which are consistent with the ARPES measurements. At the same time, some discrepancies remain between the calculated and experimentally observed detailed band structures (Fig. S10 [38]), suggesting that further theoretical developments will be required for a fully quantitative description of the electronic structure.

Intriguingly, as illustrated in Fig. 4(d), the single-particle coherence is restored at temperatures below T_N . This temperature-driven crossover from incoherent to coherent excitations bears resemblance to systems with long-range magnetic order. Yet, no such order exists in CsCr_6Sb_6 . Instead, we propose that this crossover unambiguously signals enhanced Kondo screening at lower temperatures—a conclusion firmly supported by experimental evidence.

In conventional magnetically ordered systems, local moments exhibit strong fluctuations above the ordering temperature, resulting in the loss of single-particle excitation coherence. As the system cools below the ordering temperature, the gradual freezing of magnetic fluctuations leads to the restoration of coherent single-particle excitations, typically accompanied by an increase in local moment amplitude. Strikingly, CsCr_6Sb_6 presents a fundamentally different scenario—not only does it lack long-range magnetic order, but also our measurements reveal a progressive suppression of local moment amplitude with decreasing temperature. This unconventional behavior is quantitatively demonstrated through our DMFT analysis. Figures 4(e) and 4(f) present the probabilities of DMFT atomic states and imaginary-time local spin-spin correlation functions, respectively, which provide direct insight into the temperature evolution of local moments. Figure 4(e) reveals that the atomic states contributing to local moments remain essentially unchanged across the characteristic temperature T_K . The local susceptibilities in Fig. 4(f) track how conduction electrons dynamically screen the bare local moments in Cr-3d orbitals. These correlations exhibit a rapid initial decay followed by slow saturation to small finite values—a clear signature of strong dynamical screening. Most remarkably, as temperature decreases, the long-time limit of $\langle S_z(\tau = \beta/2)S_z(0) \rangle$ shows further suppression, unambiguously signaling enhanced Kondo screening at lower temperatures. This screening mechanism effectively quenches magnetic fluctuations, thereby restoring single-particle coherence in the low-temperature regime—a behavior that stands in stark

contrast to conventional magnetic systems but is fully consistent with our experimental observations.

To explain the absence of long-range magnetic order in CsCr_6Sb_6 , we conducted DFT + U ($U = 4$ eV) calculations to probe its magnetic ground state. Our results reveal AFM coupling between the two kagome layers, with a preference for in-plane magnetism over out-of-plane alignment, consistent with prior studies [37]. While direct Cr-Cr exchange is hindered by spatial separation, possible mediation of interlayer coupling could arise from superexchange or double-exchange interactions along the Cr-Sb-Cr pathways. We systematically evaluated various candidate magnetic configurations [Figs. 4(g)–4(n); two David stars denote the upper and lower kagome layers within the same double-layer unit]. Among these, the configuration in Fig. 4(l) exhibits the lowest energy. However, the energy difference between the ground state and the next-lowest-lying configuration [Fig. 4(h)] is merely sub-meV—a negligible scale that underscores the near-degeneracy of competing magnetic states. Conventional DFT calculations often fail to capture short-range magnetic correlations, but our findings suggest strong local magnetic coupling in CsCr_6Sb_6 . The minimal energy differences between configurations imply that long-range order is destabilized by the interplay of nearly degenerate magnetic phases. Consequently, we conclude that CsCr_6Sb_6 hosts short-range magnetic correlations arising from localized moments embedded in a highly screened electronic environment.

Conclusion—Our comprehensive investigation of CsCr_6Sb_6 builds upon prior studies [37] to reveal a remarkable interplay of quantum phenomena in correlated kagome systems. Most notably, we use ZF- μ SR to uncover short-range magnetic order and integrate these results with DFT + DMFT calculations to elucidate the cooperative interplay among Kondo screening, magnetic frustration, and electronic correlations.

These results indicate that strong electronic correlations are tightly linked to both the significant renormalization of the flat band and the emergence of short-range magnetic order. This interplay points to a regime where frustrated magnetism and Kondo physics coexist delicately within the kagome lattice. While these observations align with proximity to a quantum-critical state, direct experimental verification of quantum criticality remains an open challenge. The contrast with CsCr_3Sb_5 's long-range AFM order is particularly instructive: while both systems feature flat bands, CsCr_6Sb_6 occupies a more nuanced regime near criticality where competition between interactions produces short-range order alongside heavy-fermion behavior.

These findings collectively establish CsCr_6Sb_6 as a prototypical system that (1) challenges the f -electron hegemony in heavy-fermion physics through its d -electron correlated flat band; (2) provides the clearest realization to date of the Kondo-geometric frustration competition, with short-range order as its definitive experimental signature;

and (3) reveals a pathway to novel quantum criticality through the interplay of Kondo and magnetic correlations. The observation of robust correlation effects in this non- f -electron kagome system, together with its flat-band and frustrated-magnetic properties, builds upon prior studies of d -orbital heavy-fermion materials [33,37]. These findings extend the scope of correlated-electron physics by deepening our understanding of the conditions that enable strong correlations to emerge in non- f -electron lattices. This Letter therefore opens multiple frontiers—from the controlled engineering of flat-band correlated materials to the exploration of new non-Fermi-liquid states arising from the rich interplay of Kondo physics, frustrated magnetism, and electronic correlations in quantum-critical systems.

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Data availability—There are no publicly available research data or software supporting this manuscript. Requests for further information or data should be sent to the authors.

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