

Orbital-selective spin-triplet superconductivity in infinite-layer LaNiO₂Fabian Jakubczyk^{1,2,*}, Armando Consiglio^{1,2,3,4}, Domenico Di Sante^{1,5}, Ronny Thomale^{1,2,3} and Carsten Timm^{1,2}¹*Institute of Theoretical Physics, Technische Universität Dresden, 01069 Dresden, Germany*²*Würzburg-Dresden Cluster of Excellence ct.qmat, Technische Universität Dresden, 01062 Dresden, Germany*³*Institut für Theoretische Physik und Astrophysik, Universität Würzburg, 97074 Würzburg, Germany*⁴*Istituto Officina dei Materiali, Consiglio Nazionale delle Ricerche, I-34149 Trieste, Italy*⁵*Department of Physics and Astronomy, University of Bologna, 40127 Bologna, Italy*

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The discovery of superconductivity in infinite-layer nickelates has ignited stark interest within the scientific community, particularly regarding its likely unconventional origin. Conflicting magnetotransport measurements report either isotropic or anisotropic suppression of superconductivity in an external magnetic field, with distinct implications for the nature of superconducting order. In order to ensure a most suited model subject to subsequent many-body analysis, we develop a first-principles-guided minimal theory including Ni $d_{x^2-y^2}$, La $d_{3z^2-r^2}$, and La d_{xy} orbitals. Amended by the consideration of orbital-selective pairing formation, which emphasises the correlation state of the Ni $3d_{x^2-y^2}$ orbital, we calculate the superconducting ordering susceptibility mediated by spin fluctuations. We find a parametric competition between even-parity d -wave and, in contrast to previous studies, odd-parity p -wave pairing, which becomes favorable through a large quasiparticle weight renormalization for Ni $3d_{x^2-y^2}$ electrons. Our findings not only shed light on the distinctiveness of LaNiO₂ as compared to cuprate superconductors or nickelates of different rare-earth composition but also suggest similarities to other candidate odd-parity superconductors.

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Introduction. Since the initial discovery of superconductivity in Sr-doped NdNiO₂ thin films [1], the family of nickelate superconductors has kept on growing and by now also includes infinite-layer (IL) La_{1-x}Sr_xNiO₂, Pr_{1-x}Sr_xNiO₂, and La_{1-x}Ca_xNiO₂ [2,3]. Most intriguingly, some groups report the onset of superconductivity even in undoped IL nickelates, suggesting that the eventual ground state of sufficiently clean parent nickelates is a superconducting (SC) state [2,4–7]. Despite being isostructural to high T_c cuprates, the extend of similarity between these materials remains partially unclear, in spite of numerous studies addressing this issue [8–12].

A fundamental subject of discussion is the symmetry of the SC order parameter (OP). On the one hand, magnetotransport measurements indicate isotropic Pauli-limited behavior with singlet pairing and even parity in the IL nickelate Nd_{0.775}Sr_{0.225}NiO₂ [13]. This scenario was supported by many theoretical investigations, mostly pointing at d -wave order like in the cuprates [14–19]. On the other hand, evidence for anisotropic superconductivity that violates Pauli limiting and potential spin-triplet pairing was reported in La-based nickelate thin films [5,20,21]. Likewise, this anisotropic limiting behavior for different magnetic-field orientations has recently been observed for free-standing IL nickelate membranes [22]. Variations in the upper critical field within the nickelate family were ascribed to the different rare-earth (RE) elements, i.e., the magnetic character of the 4f electrons for the Nd³⁺ Kramers doublet as opposed to their absence in La³⁺, or the nonmagnetic singlet ground state of Pr³⁺ [23].

A rare-earth-specific order parameter is also observed by London-penetration-depth measurements [24,25].

In this Letter, we address the open question of gap structure and potential odd-parity pairing in IL LaNiO₂. The largest deviation from the cuprates as well as the strongest effective-mass enhancement can be expected in the absence of doping. A direct comparison between for instance NdNiO₂ and LaNiO₂ reveals that this effect is particularly strong in the lanthanum compound [16]. Moreover, LaNiO₂ does not host any 4f electrons, who may influence the SC pairing [26]. Hybridization with 4f electrons is expected to be non-negligible in Nd and Pr nickelates [26–29]. To resolve this puzzle, we adopt the perspective of spin-fluctuation-mediated unconventional superconductivity [30] and incorporate the effect of increased correlations via the orbital-selective approach known from iron-based superconductors [31–33]. Our calculations reveal that spin-triplet pairing can indeed be realized in LaNiO₂, once an enhanced effective mass of the Ni $3d_{x^2-y^2}$ electrons is taken into account.

Low-energy electronic structure. In contrast to the parent compounds of the cuprates, which exhibit long-range antiferromagnetic order, clear signatures of long-range magnetism are lacking for IL nickelates, suggesting a paramagnetic ground state, in particular for LaNiO₂ [34–36]. Magnetism is often triggered by strong electronic correlations, which indeed exist in IL nickelates [9,16,37,38]. In fact, stable magnetic order was proposed based on *ab initio* calculations [9,27,39,40]. The unexpected absence of long-range magnetic order might be explained by the coupling to itinerant RE electrons, i.e., by the destruction of long-range order via self-doped holes, an effect not well captured by mean-field calculations [9,41].

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Nevertheless, nonlocal spin fluctuations have been observed in IL nickelates [14–16,27,35,36,41–43], which makes spin-fluctuation-mediated superconductivity the most reasonable mechanism. Furthermore, muon spin rotation (μ SR) has recently demonstrated intrinsic short-range magnetic order, also in the superconducting state [4]. Scanning-SQUID measurements found paramagnetic response in $\text{La}_{0.85}\text{Sr}_{0.15}\text{NiO}_2$, together with an inhomogeneous ferromagnetic background independent of the RE element [44]. However, short-range magnetic order is not expected to significantly alter the electronic band structure since magnetic effects lacking long-range periodicity are averaged out. This results in a Fermi surface that is very similar to the one in the absence of magnetism. The excellent match between recent ARPES measurements on Sr-doped LaNiO_2 [45] and band-structure calculations of nonmagnetic LaNiO_2 [12,14,38,40,45] supports this conclusion.

In nonmagnetic LaNiO_2 , the principal contribution at the Fermi level arises from a band primarily governed by Ni $3d_{x^2-y^2}$ electrons. This results in a large hole-like and mostly two-dimensional Fermi surface (FS) similar to the cuprates. In addition, another hybridized band of mixed Ni $3d$ and La $5d$ character creates small ellipsoidal, electron-like pockets around the Γ and A high-symmetry points of the Brillouin zone, indicating the multiorbital and three-dimensional (3D) character of LaNiO_2 [12,40,46]. These two electron pockets enable self-hole-doping of the large $d_{x^2-y^2}$ Fermi sheet, a process with major involvement of La $5d$ states [9,37]. Especially La $5d_{z^2}$ and La $5d_{xy}$ orbitals are known to have significant weight on the FS [9,12,14], where d_{z^2} is a shorthand notation for $d_{3z^2-r^2}$. Furthermore, these partially occupied electron pockets might give rise to the negative Hall coefficient, to the slightly metallic behavior of the resistivity at high temperatures, and possibly even to the superconductivity in undoped IL nickelates [2,3,14].

Hole-doping the system for instance with Sr induces changes in the electronic structure. It reduces the self-doping effect by first shifting the Γ pocket above E_F , followed by the pocket around A in the overdoped region [9,16,45,47,48]. Furthermore, doping reduces the charge-transfer energy [47], i.e., overall increases the cuprate-like character of the nickelates. However, the impact on LaNiO_2 is expected to be less pronounced compared to Nd-/Pr-based compounds regarding charge carriers, which is evidenced by the persistent negative Hall coefficient of $\text{La}_{1-x}\text{Sr}_x\text{NiO}_2$ even upon doping [2,3].

In our effective low-energy Hamiltonian, based on the nonmagnetic electronic structure of the system, we thus include Ni $d_{x^2-y^2}$, La d_{z^2} , and La d_{xy} orbitals and introduce the operator $\psi_{\sigma}^{\dagger}(\mathbf{k}) = [c_{1\sigma}^{\dagger}(\mathbf{k}), c_{2\sigma}^{\dagger}(\mathbf{k}), c_{3\sigma}^{\dagger}(\mathbf{k})]$ to describe the given multiband system. Here, $c_{l\sigma}^{\dagger}(\mathbf{k})$ is the fermionic creation operator, where σ and l denote the spin and orbital index, with $l = 1, 2, 3$ referring to the La $5d_{z^2}$, La $5d_{xy}$, and Ni $3d_{x^2-y^2}$ orbital, respectively. We thus write the noninteracting Hamiltonian as

$$H_0 = \sum_{\mathbf{k}\sigma} \psi_{\sigma}^{\dagger}(\mathbf{k}) h(\mathbf{k}) \psi_{\sigma}(\mathbf{k}), \quad (1)$$

where $h(\mathbf{k})$ is constructed utilizing hopping amplitudes obtained from the Wannier downfolding of the band structure derived from density functional theory (DFT), wherein spin

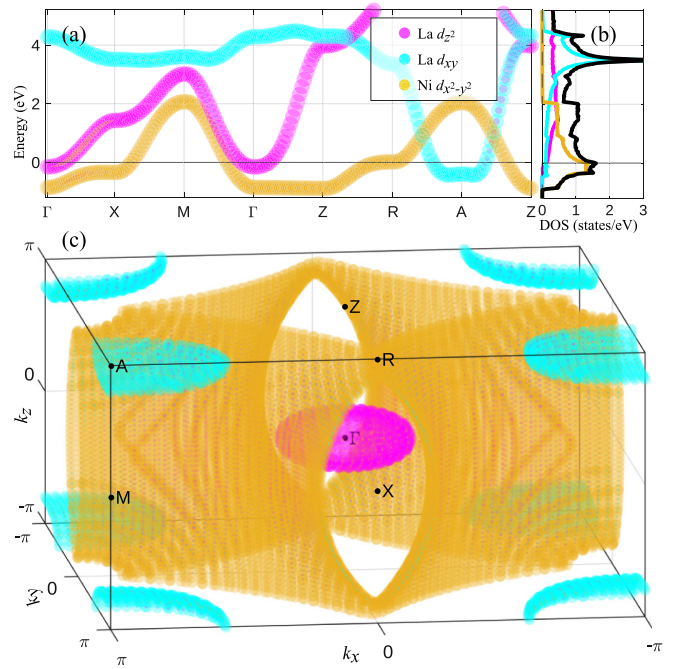


FIG. 1. (a) Band structure, (b) density of states, and (c) 3D Fermi surface including the orbital contributions relevant for the low-energy description of pristine LaNiO_2 without inclusion of renormalized quasiparticle weights. Magenta, cyan, and yellow refer to the La d_{z^2} , La d_{xy} , and Ni $d_{x^2-y^2}$ orbitals, respectively.

polarization is not taken into account. Thereby, we capture the important characteristics, as well as the distribution of orbital characters, of the nonmagnetic FS in agreement with previous DFT [14,27,49] and alternative approaches such as DFT+ U [9,50], DFT + dynamical mean-field theory (DMFT) [38,40] or the GW approximation [51]. Details on the *ab initio* calculations including further justification of the nonmagnetic electronic structure, as well as the Hamiltonian $h(\mathbf{k})$ are given in the Supplemental Material (SM) [52]. In Fig. 1, we plot the orbitally resolved single-particle band structure, as well as the corresponding 3D FS and density of states (DOS) of our minimal model. Here, La $5d_{z^2}$ weight is located mostly around Γ , while the La $5d_{xy}$ electrons have a major contribution around the A point.

Strong correlations and magnetic response. Orbitaly differentiated correlations play an important role in IL nickelates. In particular the Ni $3d_{x^2-y^2}$ electrons are highly correlated, suggesting that they are in the vicinity of a Mott critical regime [40]. This is evidenced by an enhanced effective mass and thus reduced quasiparticle weight Z , which is significantly smaller for the Ni $d_{x^2-y^2}$ orbital compared to the other $3d$ orbitals [16,18,38]. In our work, we therefore focus on the effect of a highly correlated Ni $d_{x^2-y^2}$ orbital. Previous studies have reported specific values of either the effective mass or the renormalization factor Z ($m^*/m = 1/Z$) in LaNiO_2 , ranging from $m^*/m \approx 2.81$ ($Z_{d_{x^2-y^2}} \approx 0.35$) [38,40], over $m^*/m \approx 4.1$ ($Z_{d_{x^2-y^2}} \approx 0.24$) [53] to $m^*/m \approx 5.5$ ($Z_{d_{x^2-y^2}} \approx 0.18$) [16] and $m^*/m \approx 7$ ($Z_{d_{x^2-y^2}} \approx 0.14$) [54] or even lower ($Z_{d_{x^2-y^2}} \approx 0$) [18]. Doping would shift the Ni $d_{x^2-y^2}$ orbital away from half filling, where electronic correlations are strongest, leading to a reduced mass enhancement [16,18,40,53].

We take this correlation-induced renormalization into account by means of the orbital selective ansatz [31,33]. In this ansatz, quasiparticles in orbital l are weighted by a factor $\sqrt{Z_l}$, i.e., $c_l^\dagger(\mathbf{k}) \rightarrow \sqrt{Z_l}c_l^\dagger(\mathbf{k})$ and the Green's function in the orbital basis becomes

$$\tilde{G}_{ll'}(\mathbf{k}, \omega_n) = \sqrt{Z_l Z_{l'}} \sum_{\mu} \frac{a_{\mu}^l(\mathbf{k}) a_{\mu}^{l'*}(\mathbf{k})}{i\omega_n - E_{\mu}(\mathbf{k})}, \quad (2)$$

where $E_{\mu}(\mathbf{k})$ is the eigenenergy of band μ . Subsequently, the bare susceptibility in orbital space $\chi_{l_1 l_2 l_3 l_4}^0$ requires a straightforward multiplication by the quasiparticle weights to derive the corresponding quantity

$$\tilde{\chi}_{l_1 l_2 l_3 l_4}^0(\mathbf{q}, \omega) = \sqrt{Z_{l_1} Z_{l_2} Z_{l_3} Z_{l_4}} \chi_{l_1 l_2 l_3 l_4}^0(\mathbf{q}, \omega) \quad (3)$$

in the correlated system [31,33,42].

In the next step, we introduce local electron-electron interactions via a multiorbital Hubbard-Hund Hamiltonian

$$\begin{aligned} H_{\text{int}} = & U_{\text{Ni}} \sum_i n_{i\uparrow} n_{i\downarrow} \\ & + U_{\text{La}} \sum_i n_{i\uparrow} n_{i\downarrow} + U'_{\text{La}} \sum_{i,l' < l} n_{il} n_{il'} \\ & + J_{\text{La}} \sum_{i,l' < l} \sum_{\sigma\sigma'} c_{il\sigma}^\dagger c_{il'\sigma'}^\dagger c_{il\sigma'} c_{il'\sigma} \\ & + J'_{\text{La}} \sum_{i,l' \neq l} c_{il\uparrow}^\dagger c_{il'\downarrow}^\dagger c_{il'\downarrow} c_{il\uparrow}, \end{aligned} \quad (4)$$

where the coupling constants U , U' , J , and J' denote the intraorbital Coulomb, interorbital Coulomb, Hund's, and pair-hopping interactions, respectively. The orbital indices $l, l' \in (1, 2)$ run over the La $5d$ orbitals d_{z^2} and d_{xy} . Throughout our calculations, we apply the relations $U' = U - (J + J')$ and $J' = J$ between the coupling constants, which are satisfied in various orbital degenerate models and if orbital wave functions can be chosen real [55,56]. Guided by prior research [14,18,38,40,53,57], we estimate the interaction strengths in this material by $U_{\text{La}}/U_{\text{Ni}} = 0.5$ and consider the values $J_{\text{La}}/U_{\text{La}} = 0.2$, as well as $J_{\text{La}}/U_{\text{La}} = 0.1$. The inclusion of on-site Hund's coupling J , i.e., of intra-atomic exchange interactions is expected to be an important ingredient for capturing the correlation physics. LaNiO₂ shows characteristic Hund's metal signatures such as the unexpected absence of long-range magnetism, the importance of high-spin configurations, metallicity, orbital differentiation, and a decrease of $Z_{d_{x^2-y^2}}$ with stronger Hund's coupling J [18,38,40,57]. These interactions are included in the calculation of susceptibilities within the random phase approximation (RPA). Note that in RPA the spin susceptibility systematically diverges once the interaction exceeds a critical value U_c and indicates a spin-density-wave instability, below which superconductivity emerges induced by spin fluctuations.

In Figs. 2(a) and 2(b), the noninteracting susceptibilities $\tilde{\chi}_{l_1 l_2 l_3 l_4}^0(\mathbf{q}, 0)$ are shown separately for the orbital contributions $l = 1, 2$, and 3 referring to La $5d_{z^2}$, La $5d_{xy}$, and Ni $3d_{x^2-y^2}$, respectively. Figure 2(a) addresses the unrenormalized case, with the main peaks located around the M and A points, similar to the cuprates [58]. These magnetic fluctuations are dominated by Ni $d_{x^2-y^2}$ electrons and strongly enhanced upon

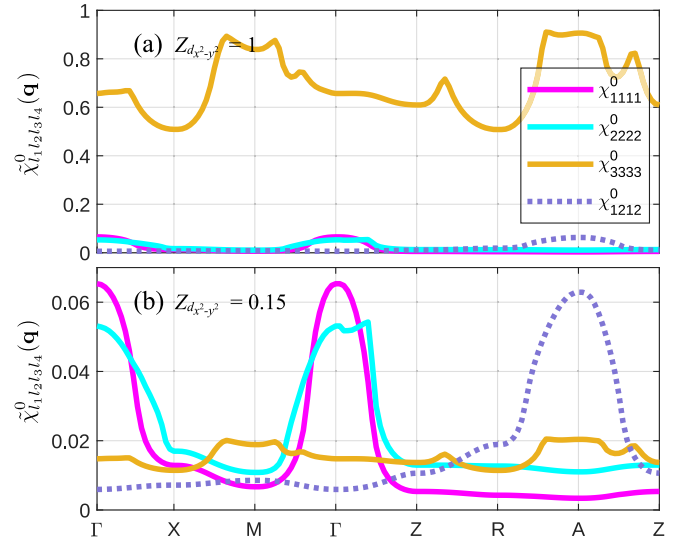


FIG. 2. Static bare susceptibilities $\tilde{\chi}_{l_1 l_2 l_3 l_4}^0(\mathbf{q}, \omega = 0)$ of parent LaNiO₂ for (a) $Z_{d_{x^2-y^2}} = 1$ and (b) $Z_{d_{x^2-y^2}} = 0.15$. Magenta, cyan, and yellow refer to the pure La d_{z^2} , La d_{xy} and Ni $d_{x^2-y^2}$ orbital contributions, respectively. The interorbital bare susceptibility $\tilde{\chi}_{1212}^0$ is shown in purple. We use $80 \times 80 \times 80$ $\mathbf{k}$ -points for momentum space integration.

introducing interactions at the RPA level. In contrast, the diagonal contributions of the La d_{z^2} and d_{xy} orbital reach their maximum around Γ . Moreover, we observe a sizable interorbital $\tilde{\chi}_{1212}^0$ feature around the A point.

Physically reasonable reduction of the Ni $d_{x^2-y^2}$ quasiparticle weight results in a clear dominance of fluctuations stemming from the RE orbitals, as can be seen in Fig. 2(b), where $Z_{d_{x^2-y^2}} = 0.15$. Interactions predominantly lead to an enhancement of the diagonal La $5d$ peaks around Γ but also of interorbital $\tilde{\chi}_{1122}^{\text{RPA},s}$ and $\tilde{\chi}_{1221}^{\text{RPA},s}$ contributions around Γ and A, respectively. The latter are not notable on the bare level but in particular the $\tilde{\chi}_{1122}^{\text{RPA},s}$ component diverges together with the intraorbital spin susceptibilities $\tilde{\chi}_{1111}^{\text{RPA},s}$ and $\tilde{\chi}_{2222}^{\text{RPA},s}$ upon approaching U_c . Previous calculations of the LaNiO₂ static weak-coupling spin susceptibility for $\mathbf{q} = (q_x, q_y, 0)$ with converged DFT + DMFT Green's functions similarly resulted in a maximum near Γ [37]. Such a transition from primarily antiferromagnetic to ferromagnetic fluctuations stresses the necessity of reevaluating the SC pairing symmetries in the regime of strongly renormalized Ni $3d$ quasiparticle weights [59].

Spin-fluctuation pairing. Magnetic fluctuations are seen as a strong candidate for mediating superconductivity in IL nickelates [14–16,27,35,36,41–43]. In order to compute the SC pairing interactions, we thus employ a formalism based on spin-fluctuations [60–62] with the adjustment of additional quasiparticle renormalization when projecting the pairing interaction from orbital to band space [33,42]. For this purpose, we solve the linearized gap equation

$$\lambda_{\alpha} f_{\alpha}(\mathbf{k}) = \sum_j \oint_{C_j} \frac{d^2 k'_{\parallel}}{(2\pi)^2 v_F(\mathbf{k}')} \tilde{\Gamma}_{ij}(\mathbf{k}, \mathbf{k}') f_{\alpha}(\mathbf{k}'), \quad (5)$$

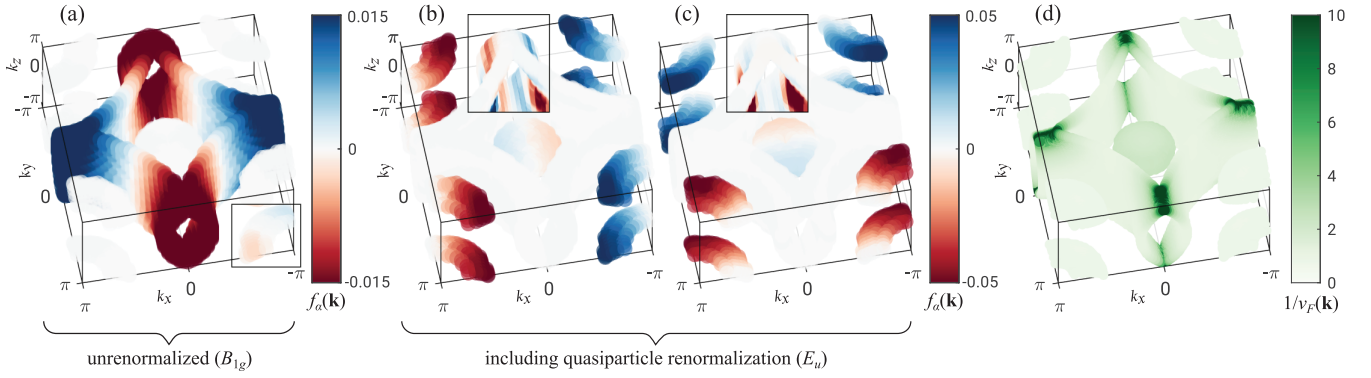


FIG. 3. Leading pairing structure of LaNiO₂ (a) without and (b), (c) with inclusion of quasiparticle renormalization. The gap symmetry changes from (a) an even-parity d -wave to (b), (c) a degenerate odd-parity p -wave solution. A color scale highlighting smaller amplitudes with maximum value of $\pm 1 \times 10^{-4}$ was chosen for the insets to reveal, e.g., in (b) and (c), the horizontal line nodes on the large FS. (d) Inverse Fermi velocity $1/v_F(\mathbf{k}) = 1/|\nabla_{\mathbf{k}} E_F(\mathbf{k})|$ giving a measure of the DOS. A total of 8504 points is taken for the 3D gap-structure calculations and we use $60 \times 60 \times 60$ $\mathbf{k}$ points for momentum space integration.

the eigenvalues of which determine the pairing strength λ_α for the various pairing channels α [63]. The largest eigenvalue results in the highest transition temperature [61], while its eigenfunction $f_\alpha(\mathbf{k})$ identifies the gap symmetry. $\tilde{\Gamma}_{ij}(\mathbf{k}, \mathbf{k}')$ represents the renormalized form of the effective multi-orbital pair scattering vertex and momenta $\mathbf{k} \in C_i$, $\mathbf{k}' \in C_j$ are constrained to the FS sheets $C_{i,j}$. A momentum-dependent measure of the DOS is given by the inverse Fermi velocity $1/v_F(\mathbf{k}) = 1/|\nabla_{\mathbf{k}} E_F(\mathbf{k})|$, which is shown in Fig. 3(d) for the rigid bands of our model. Here, van Hove features can be observed on the hole-like FS near the R points. In order to convert the integral equation (5) to an algebraic matrix equation that can be solved numerically, the area of the discretized Fermi surface segments is determined using a Delaunay triangulation procedure [33,64].

In Fig. 3, we present the leading gap-symmetry functions $f_\alpha(\mathbf{k})$ for (a) the unrenormalized and [(b) and (c)] the renormalized scenario. Unsurprisingly, a simple d -wave singlet solution is clearly favored for $Z_l = 1$, i.e., when orbital-selective renormalization is disregarded. Such a state belongs to the B_{1g} irreducible representation of the point group D_{4h} , which describes the underlying tetragonal lattice. Here, Cooper pairing from the Ni $3d_{x^2-y^2}$ orbital is predominant, with an almost vanishing gap on the RE electron pockets around Γ and A. This cuprate-like SC order has been suggested previously based on spin fluctuations [14–17,19,42].

Once we shift our model into the strongly correlated regime of $Z_{d_{x^2-y^2}} \lesssim 0.2$, solving the linearized gap equation (5) yields drastically altered results. The SC gap is now largest on the La dominated pockets, since the Ni $d_{x^2-y^2}$ quasiparticle DOS is strongly reduced. Even more importantly, two degenerate p -wave functions become favored, including a sign change on the large FS as a function of k_z and thus opposite signs on the pockets near Γ and A. These p -wave solutions belong to the two-dimensional representation E_u and are likely realized in the time-reversal-symmetry-breaking (TRSB) state, for which the weak-coupling condensation energy becomes largest compared to the remaining possible combinations of the p_x and p_y solution [65]. In the presence of weak spin-orbit coupling (see SM [52]), one naturally ex-

pects an alignment between the z -direction of the spin wave function and the crystalline c axis [66]. Therefore we can analytically approximate the numerically calculated SC OP of this spin-triplet state by

$$\mathbf{d}(\mathbf{k}) = \Delta_0 \hat{\mathbf{z}} \cos k_z (\sin k_x \pm i \sin k_y), \quad (6)$$

with the magnitude of the quasiparticle gap

$$\Delta_{\mathbf{k}} = |\mathbf{d}(\mathbf{k})| = \Delta_0 \sqrt{\cos^2 k_z (\sin^2 k_x + \sin^2 k_y)}. \quad (7)$$

Such a state is often referred to as chiral p -wave. Moreover, it is analogous to the so-called Anderson-Brinkman-Morel (ABM or axial) phase of ^3He [67,68] and has been debated extensively, e.g., for Sr₂RuO₄ [65,66,69]. The gap resulting from the $\mathbf{d}$ vector in (6) has point nodes on the electron pockets for $k_x, k_y = 0, \pm\pi$ and $k_z = \pm k_F$. In addition, line nodes are located on the large holelike FS for $k_x, k_y = k_F$ and $k_z = \pm\pi/2$. In Fig. 4, we present RPA calculations over an extensive range of input parameters to substantiate the robustness of our results. Intriguingly, our conclusions even hold when the effect of doping is included as a rigid shift of

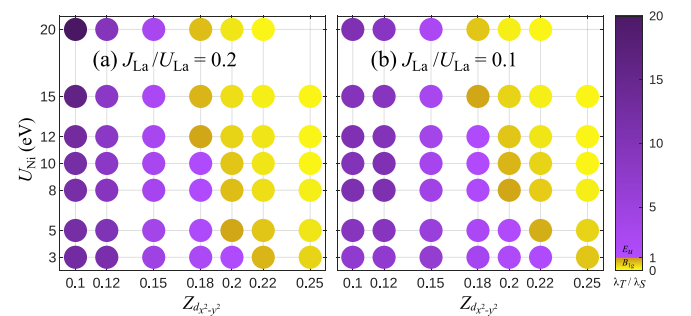


FIG. 4. Interaction- and renormalization-dependent leading solutions of the linearized gap equation for $U_{\text{La}}/U_{\text{Ni}} = 0.5$ and (a) $J_{\text{La}}/U_{\text{La}} = 0.2$, (b) $J_{\text{La}}/U_{\text{La}} = 0.1$. The color scale represents the ratio λ_T/λ_S of the eigenvalues of the favored triplet and singlet channel. The pairing symmetry is E_u or B_{1g} for a leading triplet or singlet state, respectively.

the chemical potential such that the pocket around Γ vanishes (see SM [52]). One potential yet unexplored scenario involves the doping-induced transition to a distinct OP within the SC dome.

Our proposal of chiral p -wave superconductivity with $\mathbf{d} \parallel \hat{\mathbf{z}}$ could explain the experimentally observed weaker suppression of superconductivity for an external magnetic field oriented within the basal plane [5,20,22,23]. For triplet superconductors, one would generally not expect Pauli suppression if $\mathbf{d} \cdot \mathbf{H} = 0$, i.e., the alignment $\mathbf{d} \parallel \mathbf{H}$ maximizes paramagnetic limiting effects. Moreover, the gap in Eq. (7) has point nodes and thus could cause the quadratic temperature dependence of the London penetration depth [70,71], which was attributed to a superconductor with line nodes in the presence of disorder [24,25]. Small deviations from quadratic scaling may result from additional weight at the Fermi level, due to the horizontal line nodes on the Ni $d_{x^2-y^2}$ dominated FS with low quasiparticle DOS. Besides, recent μ SR measurements provided evidence for the coexistence of short-range magnetic order and superconductivity in IL nickelates [4], which indicates TRSB.

Summary and conclusions. Our calculations of magnetic fluctuations and the resulting pairing symmetries reveal potential $p_x + ip_y$ superconductivity in IL LaNiO_2 , once an orbital-selective quasiparticle renormalization is introduced for the Ni $d_{x^2-y^2}$ electrons. From our results, we can conclude that RE physics in LaNiO_2 is not merely important for the explanation of a negative Hall conductivity [2] but that superconductivity could actually emerge from the associated bands. However, one should keep in mind that the RE metal representative strongly affects the observed phenomenology of IL nickelates. Additionally, the proposed p -wave order would resolve the controversy surrounding the anisotropic

high-field limiting behavior obtained from magnetotransport measurements [5,20,22], as well as the quadratic temperature dependence of the penetration depth [24,25,70,71]. In this regard, our effective Hamiltonian captures the relevant physics for superconductivity in 112 lanthanum nickelates, highlighting the importance of multiorbital processes and the 3D fermiology.

To conclude, our comprehensive investigation provides strong evidence that IL LaNiO_2 could exhibit spin-triplet superconductivity, a phenomenon rarely observed. This result holds promise for a new research direction within the field of SC infinite-layer nickelates in particular and for the understanding of spin-triplet pairing in general.

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Data availability. The data are not publicly available. The data are available from the authors upon reasonable request.

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