2D superconductivity of $LnO_{0.5}F_{0.5}BiS_2$ (*Ln* = La, Ce, Pr)

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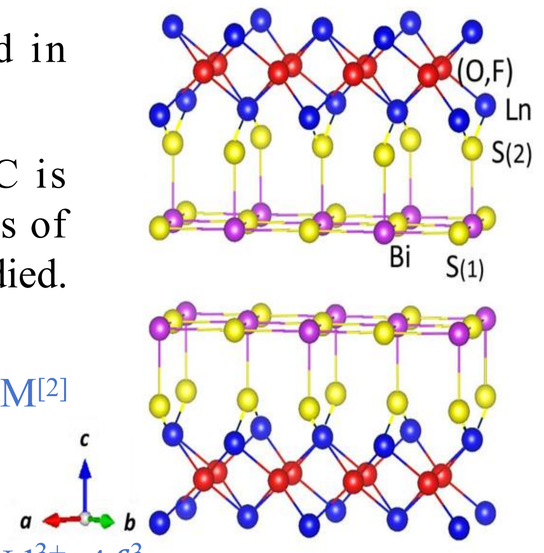
Motivations

- Interesting 2D SC discovered in $NdO_{0.5}F_{0.5}BiS_2$ recently[1].
- To expolre whether the 2D SC is intrinsic in $LnO_{0.5}F_{0.5}BiS_2$, cases of *Ln* = La, Ce and Pr need to be studied.
  - Different magnetism:

  Ln = Ce: coexistence of SC and FM[2]

  Ln = Pr: AFM tendency[3]
  - 4*f* electrons

  $La^{3+}: 4f^0$, $Ce^{3+}: 4f^1$, $Pr^{3+}: 4f^2$, $Nd^{3+}: 4f^3$

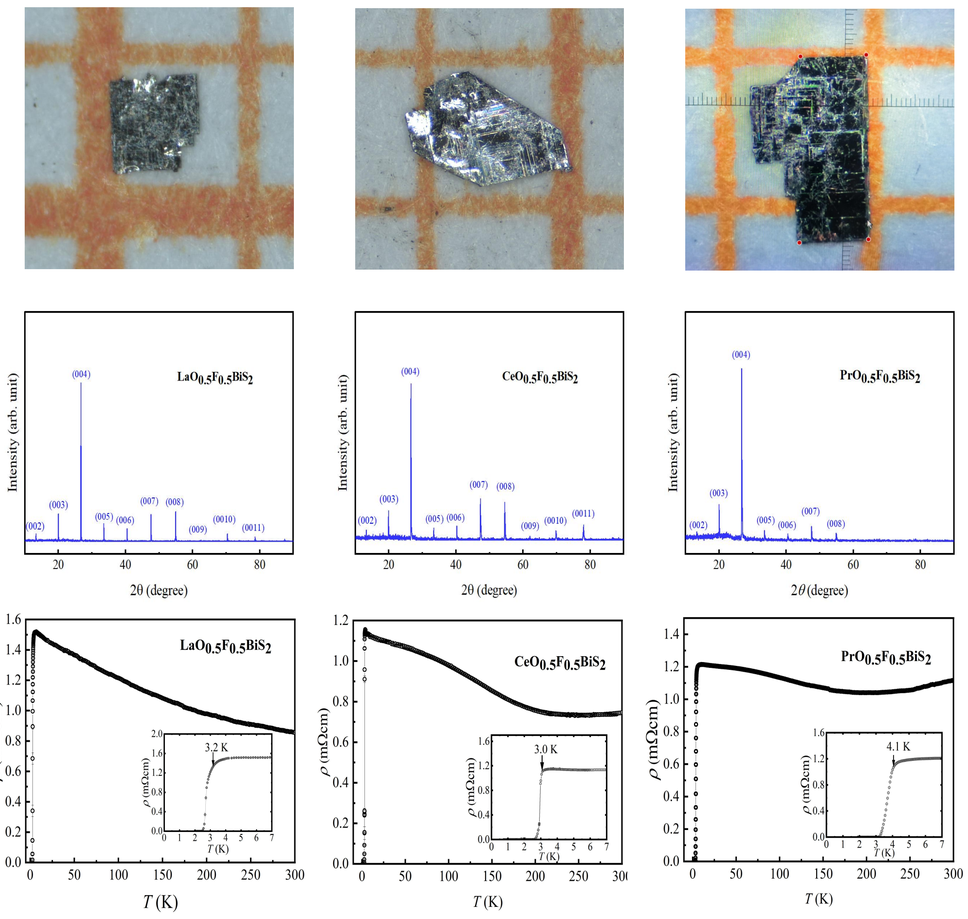


Sample characterization

$LnO_{0.5}F_{0.5}BiS_2$ (*Ln* = La, Ce, Pr) single crystals, with size ~ 0.8×0.8×0.05 mm, was grown by the improved flux method.

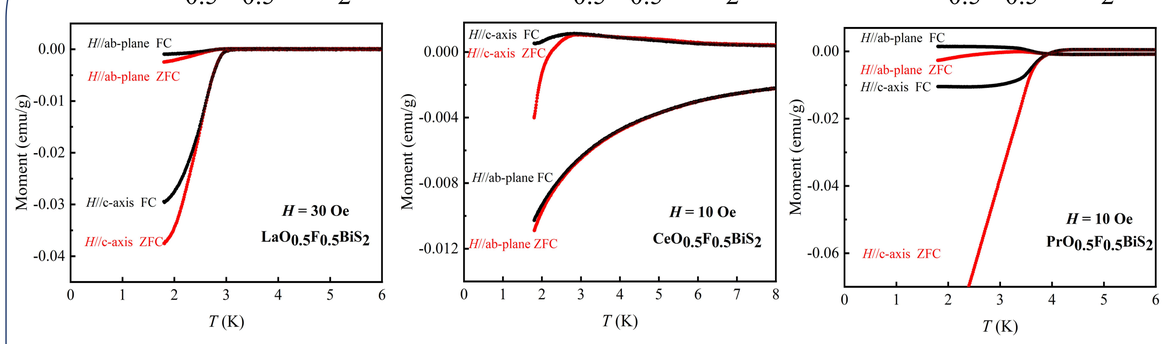
- XRD results show good quality of samples.
- SC T_c^{onset} for *Ln* = La, Ce, Pr: 3.2 K, 3.0 K, 4.1 K.

$LaO_{0.5}F_{0.5}BiS_2$ $CeO_{0.5}F_{0.5}BiS_2$ $PrO_{0.5}F_{0.5}BiS_2$



Magnetic susceptibility

$LaO_{0.5}F_{0.5}BiS_2$ $CeO_{0.5}F_{0.5}BiS_2$ $PrO_{0.5}F_{0.5}BiS_2$



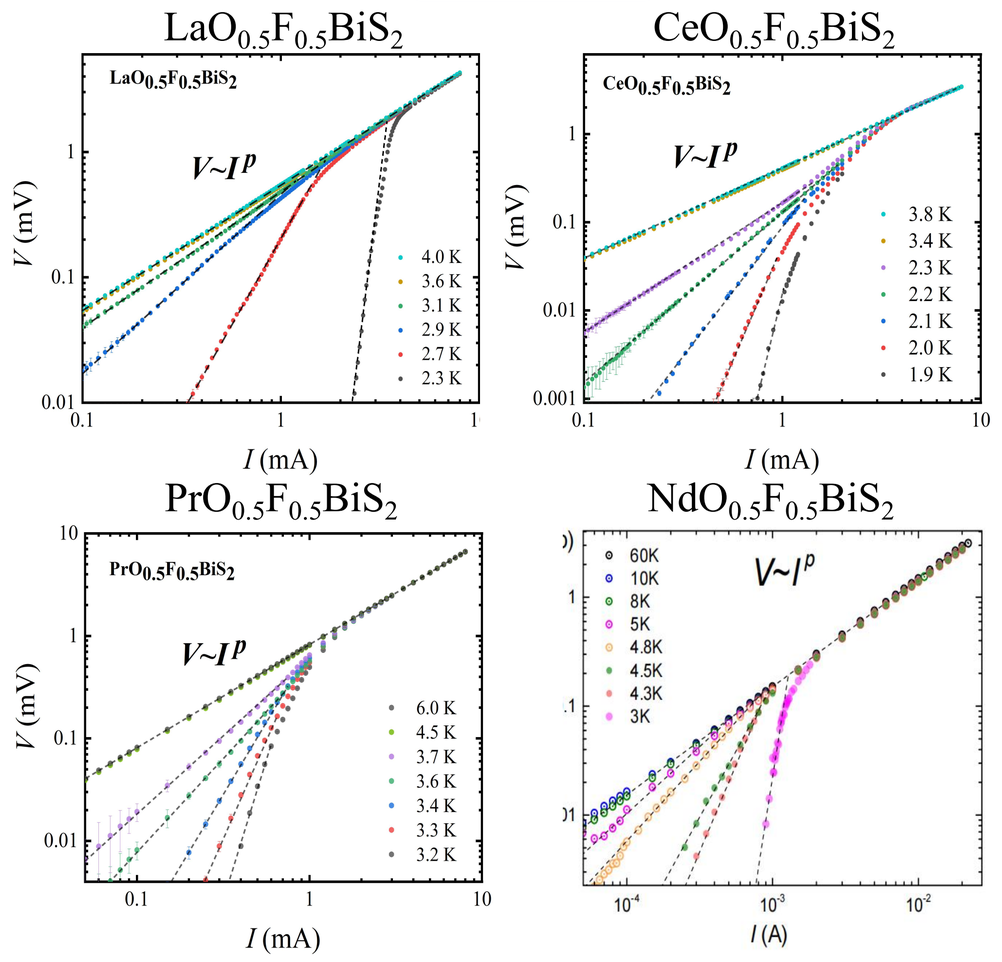
H//c-axis: stronger diamagnetism

H//ab-plane: stronger diamagnetism, no SC critical point

H//c-axis: stronger diamagnetism, stronger pinning effect

Anisotropic & clear differences!

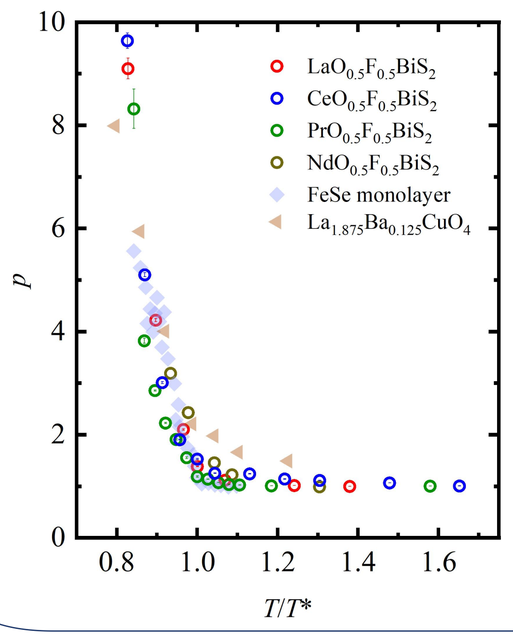
V-I curve



$LnO_{0.5}F_{0.5}BiS_2$ (*Ln* = La, Ce, Pr) show similar behaviors with $NdO_{0.5}F_{0.5}BiS_2$:

- Deviation from Ohm's law occurs $T < T^*$.
- $V = I^p$ after deviation.

BKT transition



$LnO_{0.5}F_{0.5}BiS_2$ (*Ln* = La, Ce, Pr):

- Index *p* decreases with *T* decreasing.
- *p*'s variation trends similar to *Ln* = Nd.
- Consistent with other 2D systems.
- $T_c^{offset} < \boldsymbol{T_{BKT}(p=3)} < T_c^{onset}$

Conclusion

- **BKT transitions are discoverd in $LnO_{0.5}F_{0.5}BiS_2$ (*Ln* = La, Ce, Pr, Nd), which confirms two-dimensional superconductivity.**
- **Highly consistent BKT behaviours suggest no influence of magnetism of $LnO_{0.5}F_{0.5}$ layers or 4*f* electrons on 2D superconductivity in $LnO_{0.5}F_{0.5}BiS_2$ (*Ln* = La, Ce, Pr, Nd)**

References

[1] C. S. Chen et al., Phys. Rev. B **109**, 054516 (2024)
[2] R. Jha et al., J Supercond Nov Magn **27**, 1–4 (2014)
[3] C. Morice et al., J. Phys.: Condens. Matter **28** 345504(2016)
[4] A. Miura et al., Cryst. Growth Des. **15**, 39 (2015)