Search for a Nematic Fluid at High Fields in URu_2Si_2

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In a recent science paper studying the angle dependent magnetoresistivity in $Sr_3Ru_2O_7$, Borzi et al have reported that ρ_{aa} and ρ_{bb} inside the field-induced phase don't show anisotropy when the magnetic field is applied along *c*-axis. However, when the magnetic field is 23 degree tilted to *a*-axis (rotation axis is *b* axis), ρ_{bb} shows pronounced anomaly. The authors suggest that the anisotropy observed in the magnetoresistivity suggest the formation of a nematic state with a broken rotational symmetry [1].

$U(Ru_{1-x}Rh_x)_2Si_2$ has shown a high field induced phase near the metamagnetic transition tuned by the high magnetic field, as similarly observed in $Sr_3Ru_2O_7$ [2]. To understand further the nature of the new field-induced phase in $U(Ru_{1-x}Rh_x)_2Si_2$ system, we aimed to check the magnetoresistivity anisotropy as a function of angle of the magnetic field. For this investigation in URu_2Si_2 and $U(Ru_{0.96}Rh_{0.04})_2Si_2$, the electric transport contact is prepared along *a* (ρ_{aa}) and *b* (ρ_{bb}) axis and the magnetic field is applied up to 45 T using a 50 T mid-pulse magnet in NHMFL-LANL. The direction of the magnetic field, $H_{in\text{-}plane}$, is rotated in the *a*-*c* plane and the angle is defined as that of the magnetic field direction and crystal *c*-axis.

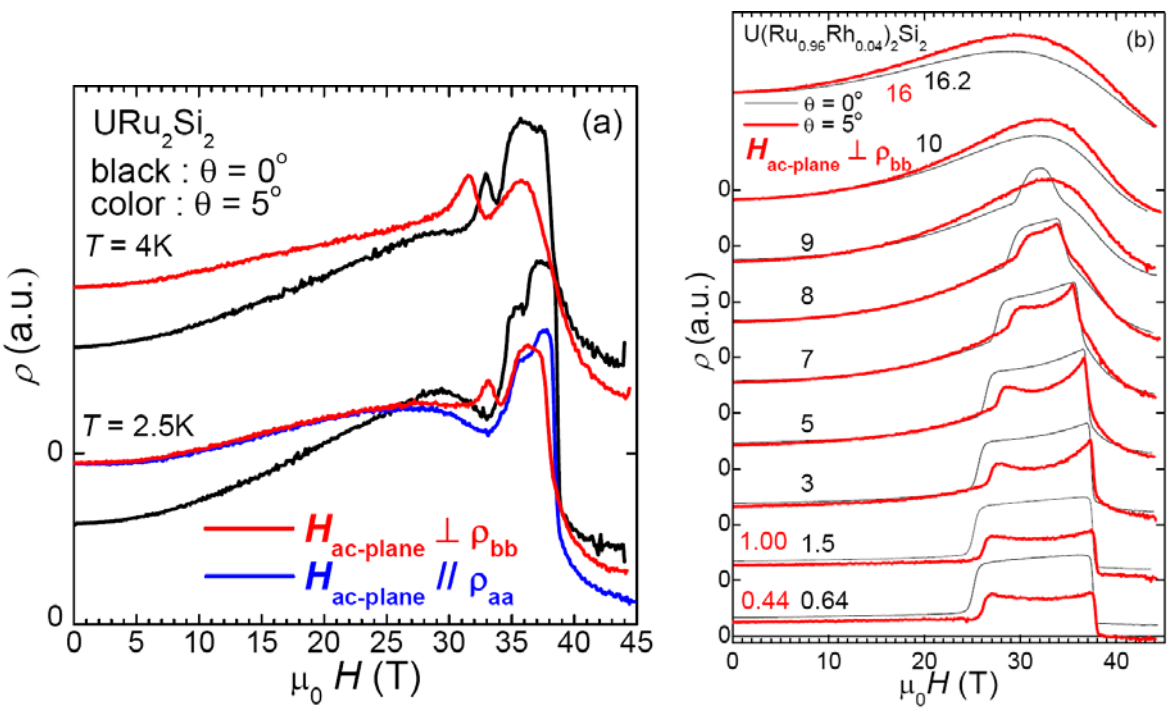

Figure 1 The angle dependence of magnetoresistivity in (a) URu_2Si_2 and (b) $U(Ru_{0.96}Rh_{0.04})_2Si_2$. The magnetic field direction is rotated 5 degree from the *c*-axis in the *a*-*c* plane toward *a*-axis direction. The red and blue lines indicate ρ_{bb} and ρ_{aa}, respectively, while *H* is applied in the *ac* plane. The black lines indicate that the applied magnetic field is along the *c*-axis.

Figure 1 (a) and (b) show the angle dependent magnetoresistivity in URu_2Si_2 and $U(Ru_{0.96}Rh_{0.04})_2Si_2$, respectively. URu_2Si_2 has various magnetic phases at low temperature as seen in the increased resistivity regions. At 2.5 K, a slight anisotropy between ρ_{aa} and ρ_{bb} seems to exist but it is unclear whether it is due to the unstable temperature caused by the magnetocaloric effect of sample or due to an intrinsic origin. $U(Ru_{0.96}Rh_{0.04})_2Si_2$ has a magnetic phase stabilized between 25 and 38 T. When the tilted magnetic field is applied, ρ_{bb} shows that the lower magnetic field phase boundary goes up to the higher magnetic field while the higher magnetic field phase boundary doesn't change much. Furthermore, ρ_{bb} seems to be quite smaller than averaged inplane resistivity measured under *H*//*c*. Overall, the data indicate a nontrivial anisotropy in ρ_{aa} and ρ_{bb} when an in-plane magnetic field exists under a tilted magnetic field. This observation prompts further studies in detail with static fields up to 33 T at Tallahassee.

[1] R. A. Borzi *et al*., Science **315**, 214 (2007).
[2] K. H. Kim *et al*., Phys. Rev. Lett. **93**, 206402 (2004).