Magnetic and electronic phases of U$_2$Rh$_3$Si$_5$

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Motivation and scientific background
- Antiferromagnetic ground state (see Fig. 1) [1,2]
- Unique magnetic transition accompanied by a structural transition [1,2]
  ➢ Possible Explanation: Bootstrapping scenario [3]
- Here: Detailed study of the magnetic and electronic properties of U$_2$Rh$_3$Si$_5$ [4]

![Crystallographic and magnetic structure of U$_2$Rh$_3$Si$_5$.](image1)

High-field measurements
- Magnetization for $B||a$ and $B||b$ and magnetostriction of the $b$ axis in pulsed magnetic fields (see Fig. 2, 3)
- Sharp jumps at transition fields
  ➢ First order transitions
- No phase transition measured for the $c$ axis up to 65 T [4]
- Various steps in the magnetization of the $a$ axis

![Magnetization of U$_2$Rh$_3$Si$_5$ in pulsed magnetic fields for (a) $B||a$ and (b) $B||b$.](image2)

![Axial magnetostriction of U$_2$Rh$_3$Si$_5$ for magnetic fields along the $b$ axis.](image3)

 Resistivity and susceptibility
- Two-step transition in the resistivity for all three axes ($b$ axis shown in Fig. 4)
  - Upturn at $T^* = 26.5$ K and maximum at $T_N = 26.0$ K

![Resistivity as a function of temperature for $b$ axis.](image4)

![Comparison of the susceptibility and the resistivity for the $b$ axis.](image5)

- Comparison with the susceptibility (see Fig. 5):
  ➢ No signature at $T^*$ in the susceptibility or the structural parameters [4]
  ➢ Drop of $\chi$ at $T_N \rightarrow$ magnetic transition

Magnetic phase diagram
- Strongly anisotropic magnetic phase diagram (see Fig. 6)
  - $a$ axis: Two additional high field phases $II_a$ and $III_a$ at low temperatures
    ➢ Staircase scenario
  - $b$ axis: Intermediate phase range $I'_b$
    ➢ Additional feature in the resistivity at $T^*$
    ➢ Novel electronic phase $\text{IE}_b$?
    ➢ Interdependence of electronic, magnetic, and structural degrees of freedom in a bootstrapping scenario?
    ➢ Further studies on electronic properties?
    ➢ Hall effect, Seebeck effect, ...

![Phase diagram of U$_2$Rh$_3$Si$_5$ for (a) the $a$ and $c$ axes and (b) the $b$ axis.](image6)

Literature: