Phase diagrams of Ce_2Pd_2In intermetallic compound

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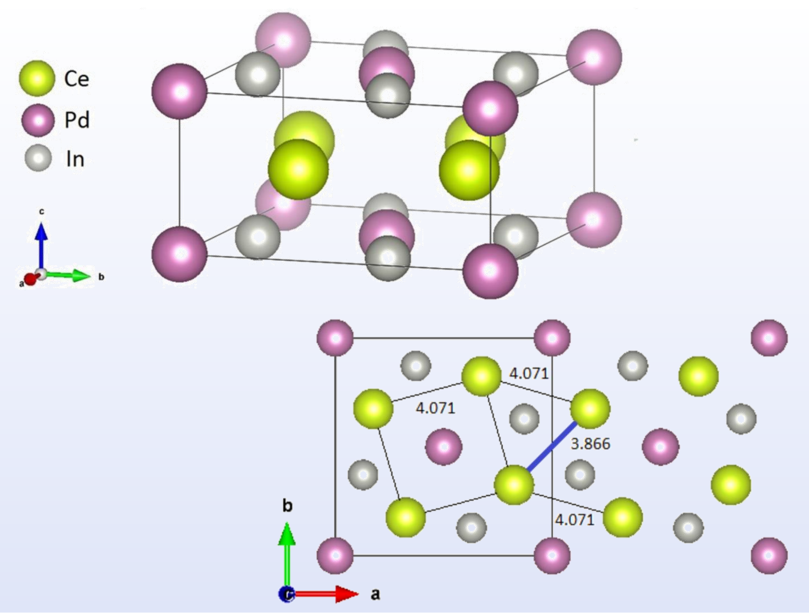
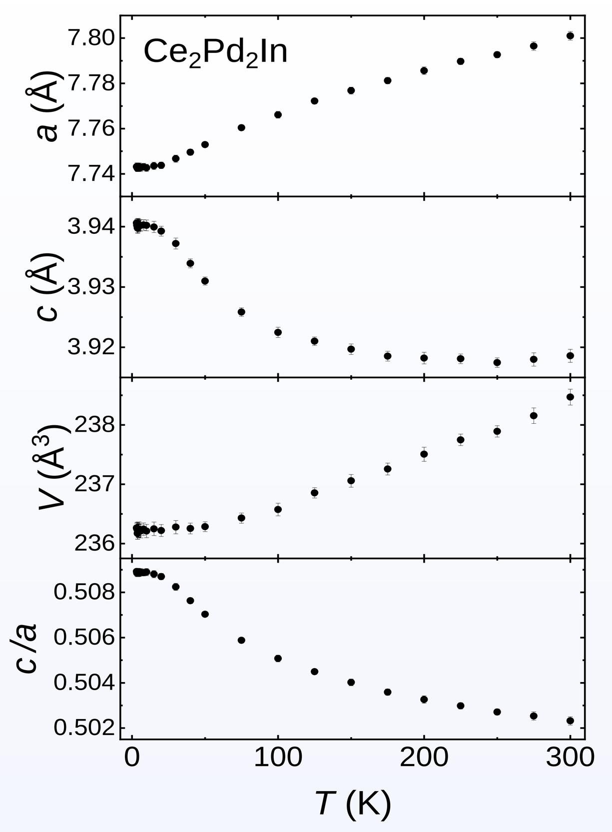
INTRODUCTION AND MOTIVATION

Thanks to the specific electronic structure the rare earth-based compounds, especially those containing Yb, Ce or Eu, often exhibit exceptional magnetic properties. In our study we have focused on cerium-based compound Ce_2Pd_2In belonging to the family of R_2T_2X compounds crystallizing in tetragonal Mo_2FeB_2-type structure [1].

Specific magnetic properties of these compounds are intimately related to details of crystal structure. The lattice is formed by *R*-planes alternated by planes containing other elements. The Ce ions in Ce_2Pd_2In lying in basal plane form Ce dimers arranged in a square motif. The Ce-Ce distance in these dimers $d_{Ce\text{-}Ce}$ = 3.866(2) is also the shortest Ce-Ce distance in this compound. Ce-distances are responsible for the character of exchange interactions and the unique way, how to affect them without changes of chemical composition, is application of mechanical pressure.

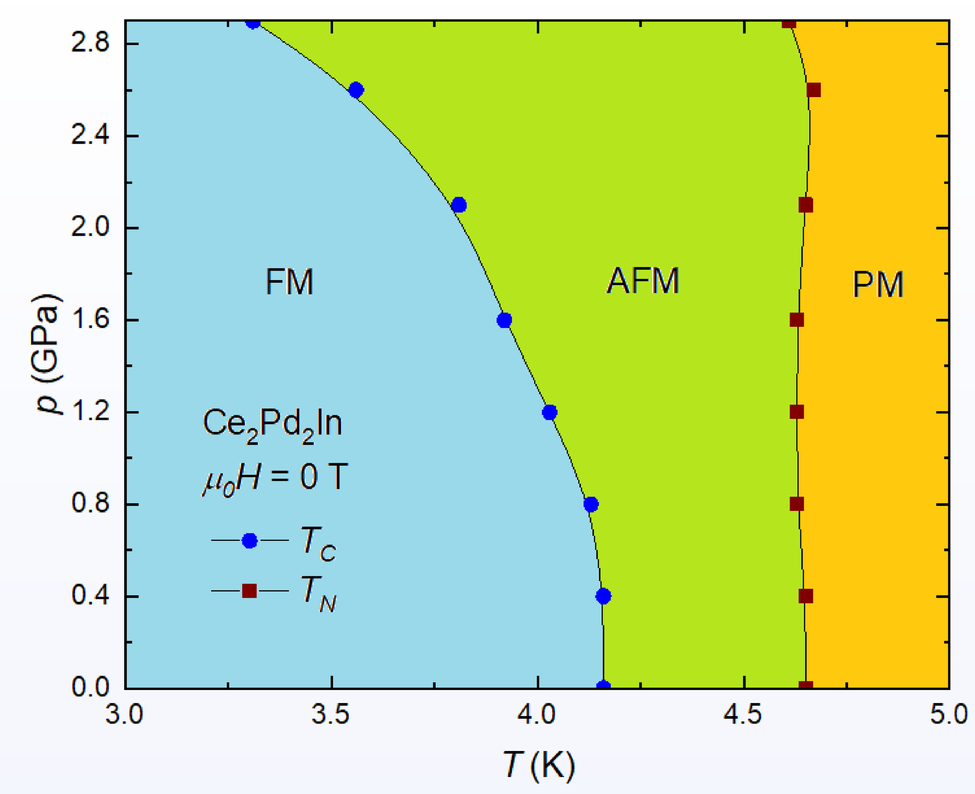


RESULTS



Temperature evolution of the lattice

- Strongly anisotropic behavior
- Decreasing the temperature
  - Parameter *a* decreases
  - Parameter *c* increases
  - Unit cell volume driven by *a*-parameter (3-times stronger impact of temperature in this direction)

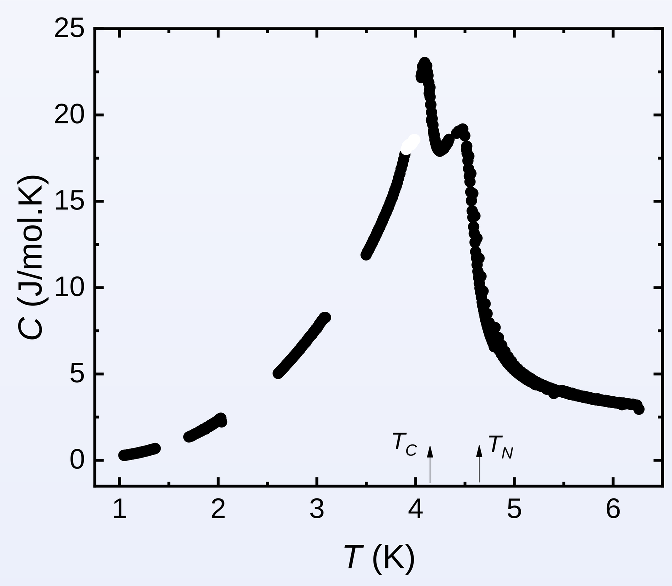


Hydrostatic pressure

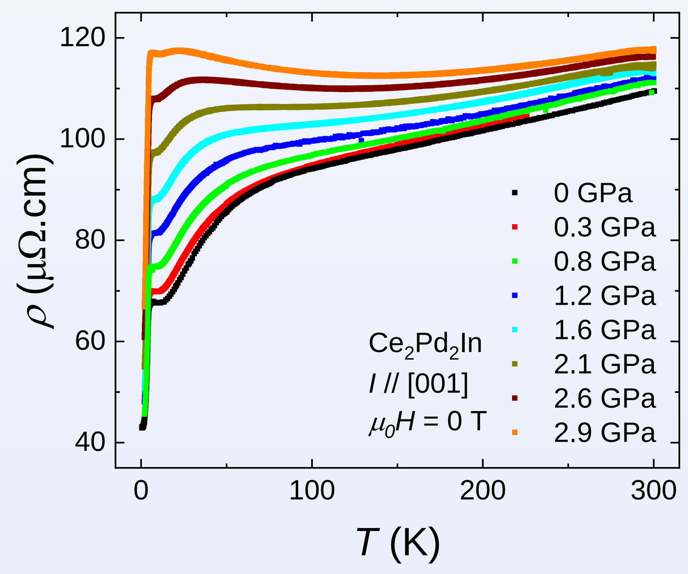
- Systematical suppression of T_C
- AFM phase remains down to the lower temperatures
- T_N almost unaffected
- Low-*T* XRD → expectation of higher impact on Ce-distances in basal plane
  - Preference of AFM interaction with respect to the FM one

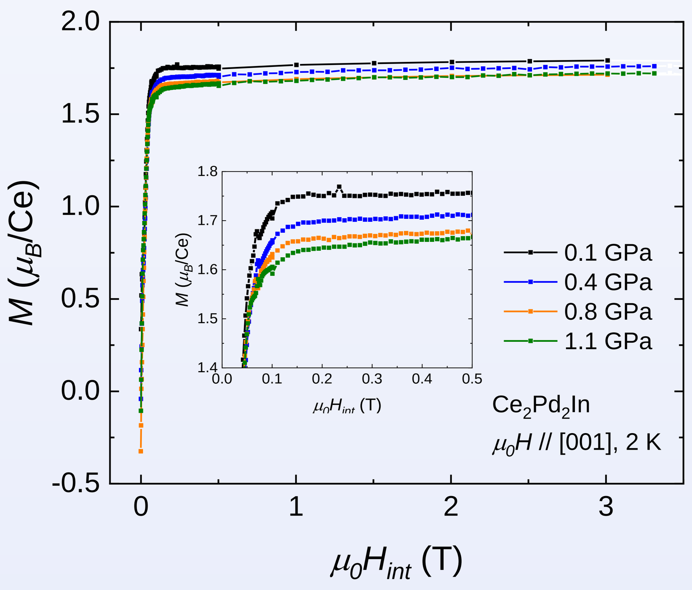
Magnetic behavior

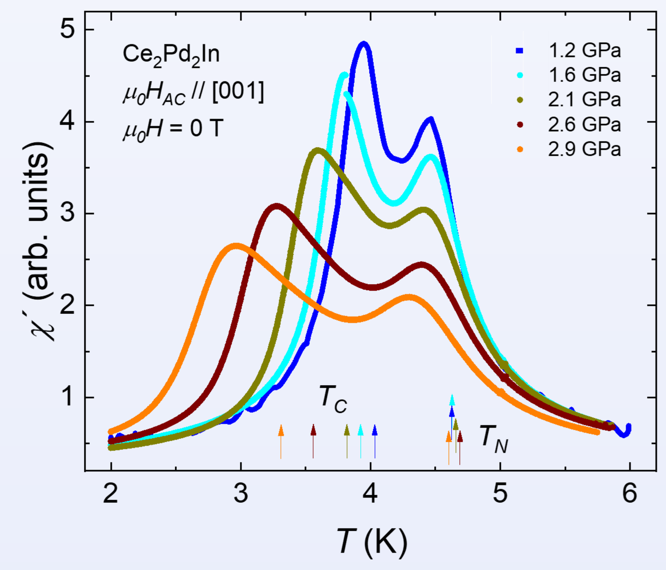
- Two successive magnetic phase transitions
  - Ferromagnetic (FM), $T_C \approx 4.16$ K
  - Antiferromagnetic (AFM), $T_N \approx 4.65$ K



- Increase of magnetic fluctuations with pressure, both hydrostatic and uniaxial, (suppression of Ce-moment, increase of *ρ* (2 K))

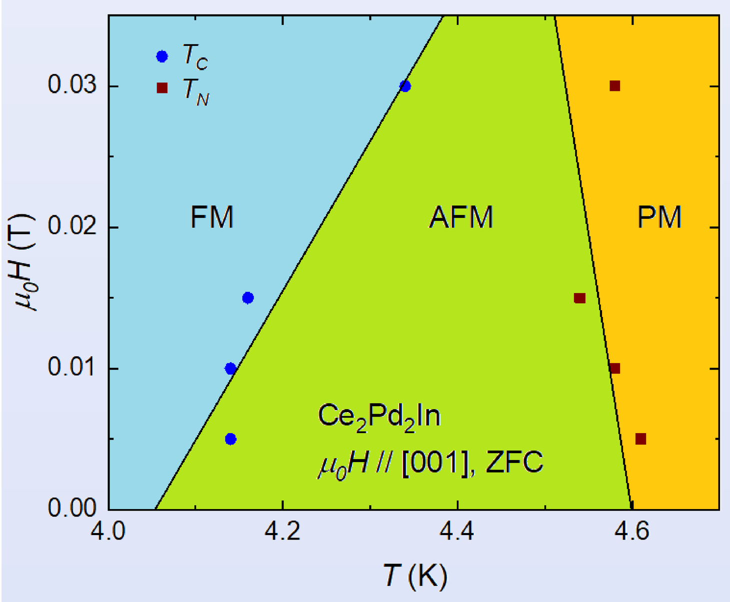


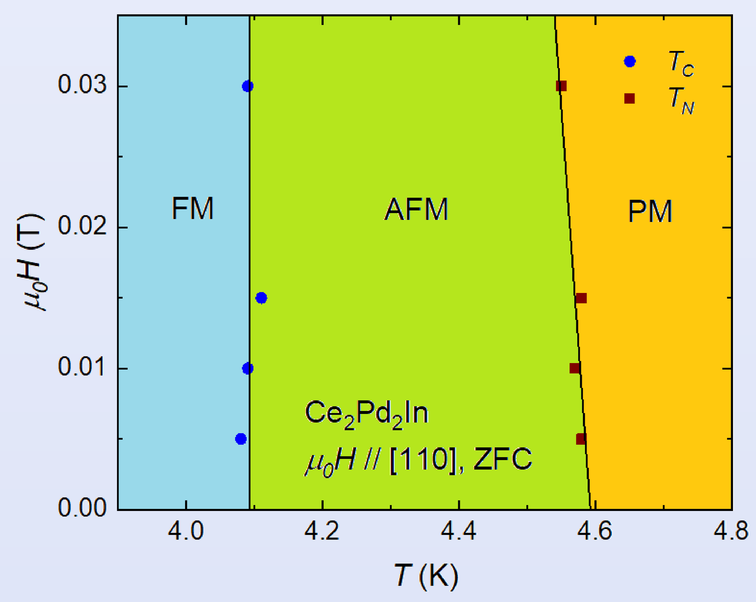




Effect of magnetic field on phase transitions

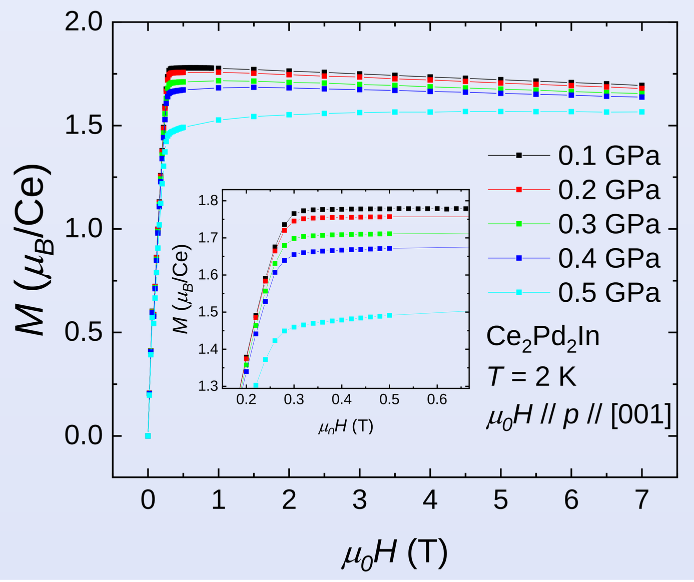
- μ_0H // [001] → Anomalies broadened and overlapped already in small magnetic field of ≈ 0.05 T
- μ_0H // [110] → Critical temperatures not affected up to 0.1 T

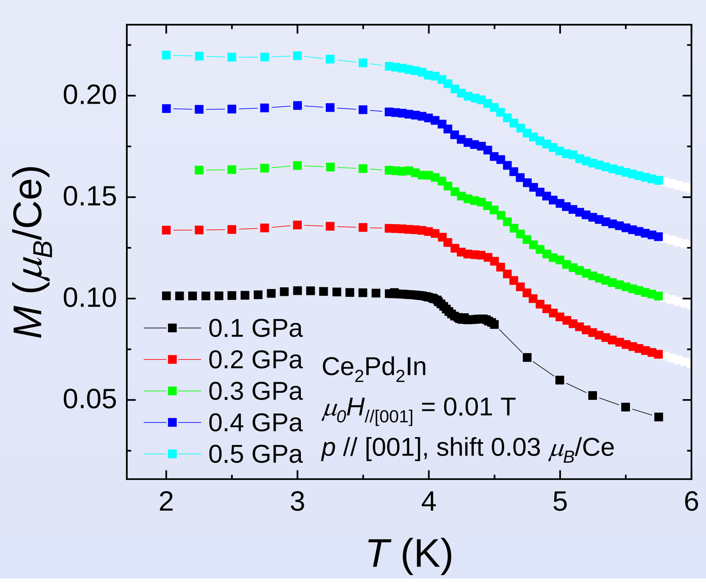


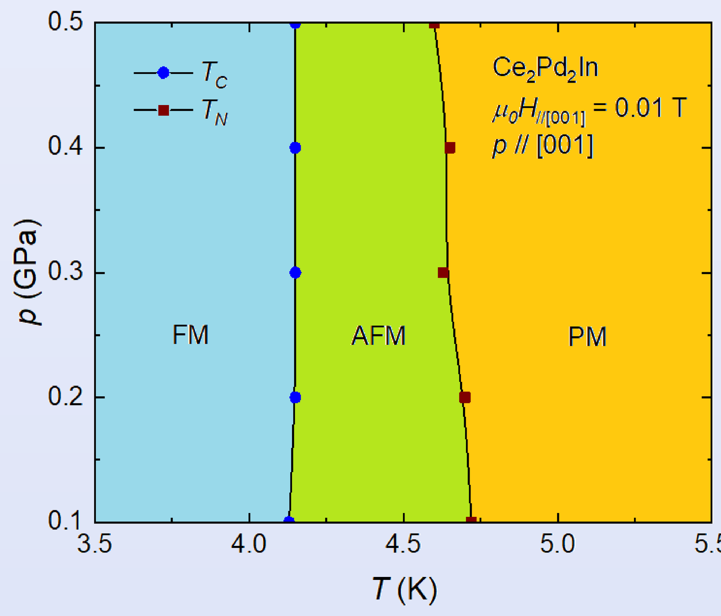


Uniaxial pressure

- Acting on the *c*-axis → different impact compared to the hydrostatic pressure
- No significant effect on the temperatures of phase transitions







EXPERIMENTAL DETAILS

High quality single-crystalline sample used for experiments was prepared by Czochralski growth method.

A double layer cylindrical pressure cell with nominal pressure range up to 3 GPa was employed for measurement of electrical resistivity and AC magnetic susceptibility under hydrostatic pressure [2].

In order to apply the uniaxial pressure, the CuBe uniaxial pressure cell allowing to measure the magnetization was used [3].

SUMMARY

Crystal lattice evolution is strongly anisotropic, decreasing of temperature leads to decrease of *a*-parameter and increase of parameter *c*. Volume changes are driven mainly by parameter *a*.

Magnetic transitions of Ce_2Pd_2In are sensitive to external magnetic field and to application of mechanical pressure. Field along [001] results in suppression of AFM phase, hydrostatic pressure leads to suppression of FM phase. Field along [110] as well as the uniaxial pressure do not affect critical temperatures significantly.

References: [1] M. Klicpera et al., *J. Magn. Magn. Mater.* **404**, 250 (2016); [2] N. Fujiwara et al., Rev. Sci. Instrum. **78**, 073905 (2007); [3] J. Kamarád et al., High Press Res **28**, 633 (2008)

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