



Julia Ferstl (Autor)

## New Yb-based systems: From an intermediate-valent to a magnetically ordered state

Julia Ferstl

New Yb-based systems: From an intermediate-valent to a magnetically ordered state



Cuvillier Verlag Göttingen

<https://cuvillier.de/de/shop/publications/1685>

Copyright:

Cuvillier Verlag, Inhaberin Annette Jentzsch-Cuvillier, Nonnenstieg 8, 37075 Göttingen, Germany

Telefon: +49 (0)551 54724-0, E-Mail: [info@cuvillier.de](mailto:info@cuvillier.de), Website: <https://cuvillier.de>

# Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
<b>2</b>	<b>Introduction to 4f-based heavy Fermions</b>	<b>5</b>
<b>3</b>	<b>YbFe<sub>2</sub>Ge<sub>2</sub> and its ‘reference’ compound LuFe<sub>2</sub>Ge<sub>2</sub>: paramagnetic Fe moment</b>	<b>21</b>
3.1	Introduction.....	21
3.2	YbFe <sub>2</sub> Ge <sub>2</sub> .....	23
3.2.1	Crystal growth.....	23
3.2.2	Physical properties of YbFe <sub>2</sub> Ge <sub>2</sub> .....	30
3.2.2.1	Resistivity.....	30
3.2.2.2	Specific heat.....	35
3.2.2.3	Magnetic properties.....	39
3.2.2.3.1	Susceptibility.....	39
3.2.2.3.2	Magnetisation.....	43
3.3	LuFe <sub>2</sub> Ge <sub>2</sub> .....	45
3.3.1	Crystal growth.....	45
3.3.2	Physical properties of LuFe <sub>2</sub> Ge <sub>2</sub> .....	50
3.3.2.1	Resistivity.....	50
3.3.2.2	Specific heat.....	52
3.3.2.3	Magnetic properties.....	56
3.3.2.3.1	Susceptibility.....	56
3.3.2.3.2	Magnetisation.....	65
3.4	Neutron scattering.....	68
3.5	LDA calculations.....	73

3.6	Final discussion of YbFe <sub>2</sub> Ge <sub>2</sub> and LuFe <sub>2</sub> Ge <sub>2</sub> .....	76
3.6.1	Paramagnetic Fe moment.....	76
3.6.2	Spin fluctuations and magnetic order in LuFe <sub>2</sub> Ge <sub>2</sub> .....	77
3.6.3	Intermediate valency and heavy-fermion behaviour in YbFe <sub>2</sub> Ge <sub>2</sub> .....	78
3.7	Summary.....	82

## **4 Pure and doped YbRh<sub>2</sub>Si<sub>2</sub>: Crossing the QCP** 83

4.1	Introduction.....	83
4.1.1	Review.....	83
4.1.2	Aim of this work.....	89
4.2	Crystal growth.....	90
4.2.1	Introduction .....	90
4.2.2	Crystal growth of pure YbRh <sub>2</sub> Si <sub>2</sub> .....	92
4.2.3	Crystal growth of doped YbRh <sub>2</sub> Si <sub>2</sub> .....	96
4.2.3.1	Crystal growth of YbRh <sub>2</sub> (Si <sub>1-x</sub> Ge <sub>x</sub> ) <sub>2</sub> .....	96
4.2.3.2	Crystal growth of Yb <sub>1-x</sub> La <sub>x</sub> Rh <sub>2</sub> Si <sub>2</sub> and Yb <sub>0.95</sub> Y <sub>0.05</sub> Rh <sub>2</sub> Si <sub>2</sub> ...	102
4.3	Lattice constants.....	105
4.4	Physical properties.....	108
4.4.1	Resistivity.....	108
4.4.1.1	Resistivity of pure YbRh <sub>2</sub> Si <sub>2</sub> .....	108
4.4.1.2	Resistivity of Yb <sub>1-x</sub> La <sub>x</sub> Rh <sub>2</sub> Si <sub>2</sub> .....	111
4.4.2	Specific heat.....	116
4.4.2.1	Specific heat of pure YbRh <sub>2</sub> Si <sub>2</sub> .....	116
4.4.2.2	Specific heat of Yb <sub>1-x</sub> La <sub>x</sub> Rh <sub>2</sub> Si <sub>2</sub> .....	126
4.5	Magnetic properties.....	130
4.5.1	Susceptibility.....	131
4.5.1.1	Susceptibility of pure YbRh <sub>2</sub> Si <sub>2</sub> in both directions.....	131
4.5.1.2	Comparison of susceptibility of all La-doped YbRh <sub>2</sub> Si <sub>2</sub> ....	135
5.5.2	Magnetisation.....	137
4.6	Neutron scattering.....	138

4.7	ESR.....	145
4.7.1	ESR signal in pure $\text{YbRh}_2\text{Si}_2$ .....	146
4.7.2	ESR signal in $\text{Yb}_{1-x}\text{La}_x\text{Rh}_2\text{Si}_2$ .....	148
4.8	Muon spin relaxations in $\text{Yb}_{0.95}\text{La}_{0.05}\text{Rh}_2\text{Si}_2$ .....	150
4.9	Summary.....	151
<b>5</b>	<b>Magnetic order of well localised <math>\text{Yb}^{3+}</math> moments in <math>\text{Yb}_4\text{Rh}_7\text{Ge}_6</math></b>	<b>155</b>
5.1	Crystal growth.....	155
5.2	Physical properties.....	160
5.2.1	Magnetic properties: susceptibility and magnetisation.....	161
5.2.2	Resistivity.....	163
5.2.3	Anomalous specific heat and entropy.....	166
5.3	Discussion and comparison with other Yb-based compounds..	169
5.4	Summary.....	170
<b>6</b>	<b>Summary</b>	<b>171</b>
<b>Bibliography</b>		<b>175</b>