



UvA-DARE (Digital Academic Repository)

Evolution of Magnetism and its Interplay with Superconductivity in Heavy-Fermion $U(\text{Pt},\text{Pd})_3$

Keizer, R.J.

Publication date
1999

[Link to publication](#)

Citation for published version (APA):

Keizer, R. J. (1999). *Evolution of Magnetism and its Interplay with Superconductivity in Heavy-Fermion $U(\text{Pt},\text{Pd})_3$* . Universiteit van Amsterdam.

General rights

It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations

If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: <https://uba.uva.nl/en/contact>, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.

Contents

Chapter 1. Introduction.....	9
1.1 General introduction	9
1.2 Outline	11
Chapter 2. Experimental techniques.....	13
2.1 Introduction	13
2.2 Sample preparation	15
2.3 The μ SR technique.....	16
2.4 Elastic neutron scattering	21
Chapter 3. Theory	27
3.1 Introduction	27
3.2 Unconventional superconductivity	28
3.2.1 Superconductivity in UPt_3	28
3.2.2 Unconventional pairing.....	29
3.2.3 The energy gap.....	31
3.2.4 The symmetry of the order parameter	32
3.2.5 Ginzburg-Landau theory	34
3.2.5.1 Introduction.....	34
3.2.5.2 E-model.....	35
3.2.5.3 AB-model.....	40
3.2.5.4 1D-rep with odd parity.....	43
3.3 The principles of μ SR	47
3.3.1 Zero field μ SR	47
3.3.2 Longitudinal field μ SR	50
3.3.3 Transverse field μ SR	50
Chapter 4. Neutron diffraction study	55
4.1 Introduction.....	55
4.2 Experimental	58
4.3 Calculation of the magnetic moment	61
4.4 Small-moment antiferromagnetic order for $0 \leq x \leq 0.01$	64
4.5 Large-moment antiferromagnetic order for $x \geq 0.01$	67
4.6 Evolution of magnetism in the $U(Pt_{1-x}Pd_x)_3$ pseudobinaries.....	70
4.7 Interplay of magnetism and superconductivity	71
4.8 Discussion.....	73
4.9 Summary	76

Chapter 5. μSR study of $U(Pt,Pd)_3$	81
5.1 Introduction	81
5.2 Experimental	85
5.3 μ SR experiments on SMAF compounds ($x \leq 0.005$)	86
5.4 LMAF probed by μ SR experiments for $x \geq 0.01$	90
5.5 Transverse field μ SR	96
5.5.1 Knight shift	96
5.5.2 Results for $U(Pt_{0.95}Pd_{0.05})_3$	98
5.6 The muon localisation site	102
5.7 Discussion	104
5.8 Summary	107
Chapter 6. Superconductivity in $U(Pt,Pd)_3$	109
6.1 Introduction	109
6.2 The SBF scenario	112
6.3 Experimental	114
6.4 Specific heat of $U(Pt_{1-x}Pd_x)_3$	115
6.5 The upper critical field	118
6.6 Thermal expansion and magnetostriction	121
6.6.1 Experimental	122
6.6.2 Thermal expansion	122
6.6.3 Magnetostriction	124
6.7 Superconducting phase diagram of $U(Pt_{0.998}Pd_{0.002})_3$	128
6.8 Ginzburg-Landau parameters of $U(Pt_{1-x}Pd_x)_3$	131
6.9 Testing the SBF model.....	132
6.10 Concluding remarks	134
Appendix I E-model: sixth order correction	142
Summary	144
Samenvatting	146
Published work	148
Dankwoord	150

Contents

Chapter 1. Introduction	1
1.1 Introduction	1
1.2 Experimental	1
1.3 USR experiments on SMAL compounds (22.0.005)	1
Chapter 2. Experimental investigation of the USR	1
2.1 Transverse field USR	1
2.2 Knight shift	1
2.3 Knight shift for $^{171}\text{Yb}^{3+}$	1
2.4 The upper excitation line	1
2.5 Discussion	1
2.6 Summary	1
Chapter 3. Theory	1
3.1 Introduction	1
3.2 The USR system	1
3.3 The ground state	1
3.4 Specific heat of $^{171}\text{Yb}^{3+}$	1
3.5 The upper critical field	1
3.6 Thermal expansion and magnetization	1
3.7 Magnetization	1
3.8 Calculating the phase diagram of $^{171}\text{Yb}^{3+}$	1
3.9 Changing Landau parameters of $^{171}\text{Yb}^{3+}$	1
3.10 Fitting the USR curve	1
3.11 Concluding remarks	1
Appendix 1. E-model: sixth-order correction	1
Appendix 2. Calculation of the Knight shift	1
Appendix 3. Summary	1
Appendix 4. Bibliography	1
Appendix 5. Published work	1
Appendix 6. Blank word	1