Contents

	Preface	page ix
1	Introduction	1
1.1	Heisenberg's philosophy of quantum mechanics	3
1.2	Heisenberg as a philosopher-physicist	8
	PART I THE EMERGENCE OF QUANTUM MECHANICS	15
2	Quantum mechanics and the principle of observability	17
2.1	The observability principle	18
2.2	The renunciation of the electron orbit and the elimination of	
	unobservables	21
2.3	Heisenberg's version of the observability principle	26
2.4	The meaning of observability: a discussion with Einstein	31
3	The problem of interpretation	36
3.1	Reconceptualising the electron's motion	37
3.2	The physical meaning of Schrödinger's wave mechanics	40
3.3	Drawing the battle lines: Heisenberg and Schrödinger on	
	understanding in physics	44
3.4	Redefining Anschaulichkeit	48
3.5	Instrumentalism or realism? Heisenberg's notion of closed	
	theories	53
	PART II THE HEISENBERG-BOHR DIALOGUE	61
4	The wave-particle duality	63
4 .1	The physical reality of the electron: wave or particle?	65

viii Contents

4.2	Probability waves and the quantum mechanics of particles	68
4.3	Quantised matter waves and wave-particle equivalence	73
4.4	Heisenberg and Bohr: divergent views of wave-particle duality	77
5	Indeterminacy and the limits of classical concepts: the	
	turning point in Heisenberg's thought	85
5.1	New concepts of space and time in quantum theory	87
5.2	The introduction of the gamma-ray microscope	92
5.3	Bohr's analysis of the limits of measurement and the meaning of	
	concepts	95
5.4	The turning point in Heisenberg's philosophy	100
6	Heisenberg and Bohr: divergent viewpoints of	
	complementarity	108
6.1	Bohr's complementarity of space-time and causal descriptions	109
6.2	The Heisenberg interpretation	112
6.3	Weizsäcker's reconstruction	116
6.4	Mutually exclusive experimental arrangements	118
6.5	The object-instrument divide	123
	PART III HEISENBERG'S EPISTEMOLOGY AND	
	ONTOLOGY OF QUANTUM MECHANICS	131
7	The transformation of Kantian philosophy	133
7.1	Heisenberg's early confrontation with Kantian philosophy	134
7.2	The doctrine of classical concepts	139
7.3	The constitutive dimension of language and the forms of	
	intuition	142
7.4	Heisenberg's transformation of the a priori	147
8	The linguistic turn in Heisenberg's thought	152
8.1	Heisenberg's conception of language	153
8.2	The language-reality problem in quantum mechanics	158
8.3	The problem of meaning	161
8.4	Actuality and potentiality	165
	Conclusion	172
	References	179
	Index	196