

Contents

1	Introduction	1
1.1	The Exactness of Science	2
1.2	Data without Uncertainty	4
1.3	Uncertainties in Every-Day Life	5
2	Basics on Data	7
2.1	Measurement Data	7
2.2	Analog vs. Digital	12
2.3	Dealing with Data (Numerals)	14
3	Basics on Uncertainties	17
3.1	General Characteristics of Uncertainties	19
3.2	Definitions	22
3.3	Uncertainty of Data Depending on One Variable	33
3.4	Multiple Uncertainty Components (Quadratic Sum)	35
3.5	Uncertainty Evaluations (Error Analysis)	40
3.6	Experimental Uncertainty	41
4	Radioactive Decay, a Model for Random Events	49
4.1	Time Interval Distribution of Radioactive Events	49
4.2	Inductive Approach to Uncertainty (Example)	57
5	Frequency and Probability Distributions	69
5.1	Frequency Distribution (Spectrum)	69
5.2	Probability Distributions	77
5.3	Statistical Confidence	87
5.4	Dealing with Probabilities	88
6	Deductive Approach to Uncertainty	93
6.1	Theoretical Situation	93
6.2	Practical Situation	93

6.3	Regression Analysis (Least-Squares Method)	105
6.4	Data Consistency within Data Sets	112
7	Correlation	115
7.1	Introduction	115
7.2	Correlated (Systematic) Uncertainties	117
7.3	Differentiation from “Systematic Errors”	130
7.4	Correlation in Cases of Linear Regression	137
7.5	Consistency among Data Sets	141
7.6	Target Shooting as a Model for Uncertainties	147
8	Dealing with Internal Uncertainties	151
8.1	Calculations with Both Types of Uncertainties	154
8.2	Total Uncertainty	163
8.3	Using Internal Uncertainties for Diagnosis	166
9	Presentation and Estimation of Uncertainties	173
9.1	Graphic Presentation, Also of Uncertainties	173
9.2	Correct Presentation of Uncertainties	180
9.3	Finding the Size of Internal Uncertainties	182
9.4	Estimating the Size of Uncertainties	184
10	Feedback of Uncertainties on Experiment Design	189
10.1	Optimizing Experiments	189
10.2	Optimizing Background Measurements	192
10.3	Optimizing with Respect to Dead Time	195
10.4	Optimizing in View of the Mathematical Presentation	197
10.5	Achieving the Smallest Overall Uncertainty	200
	Solutions	209
	Index	223