

Contents

1. Introduction	1
2. Description of the Phenomenon	11
2.1 The Classical Picture. No Serious Problems	11
2.1.1 Viscosity	11
2.1.2 Linear Response	16
2.1.3 Dynamic Glass Transition	26
2.1.4 Thermal Glass Transition. Glass Temperature. Partial Freezing	34
2.1.5 Structural Relaxation. Landscape. Nonlinearity	49
2.1.6 Final Remarks	65
2.2 Serious Problems	66
2.2.1 Crossover Region and β Process	66
2.2.2 How to Find the 'Right Questions' for Glass Transition Problems?	78
2.2.3 Different Transport Properties	79
2.2.4 Nonexponentiality	88
2.2.5 Dynamic Heterogeneity. Characteristic Length. Cooperatively Rearranging Regions CRR	94
2.2.6 Glass Structure	104
2.2.7 Fischer Modes	110
2.2.8 Similarity in Different Substances	117
2.3 High Frequency Relaxation. Not as Simple as Expected	121
2.3.1 Giga-to-Terahertz Results	122
2.3.2 Götze's Mode-Coupling Theory (MCT)	129
2.3.3 Colloidal Glass Transition	137
2.3.4 Computer Simulations	138
2.4 Long-Running Issues	149
2.4.1 Glass Transition and Flow Transition in Polymers	149
2.4.2 Hindered Glass Transition in Confining Geometries	157
2.4.3 Tunnel States at Low Temperatures	161
2.4.4 Mixed Alkali Effect	170
2.4.5 Relaxation Tails. No Deserts Between Dispersion Zones. Logarithmic Gaussian Distribution	175

2.4.6	Glass Formation	182
2.5	A Preliminary Physical Picture in 1999.....	185
2.5.1	Thermodynamic Approach. No Ideal Glass Transition?	191
2.5.2	Dynamic Approach: Strategy	206
2.5.3	Molecular Pictures	210
2.5.4	Tables	218
3.	Theoretical Framework	227
3.1	Representative Freely Fluctuating Subsystems.....	228
3.2	Gibbs Fluctuations and Thermodynamic Fluctuations.....	240
3.2.1	Gibbs Treatment of Statistical Mechanics.....	241
3.2.2	Von Laue Treatment of Thermodynamics.....	244
3.2.3	Differences and Relationships Between the Two Treatments	247
3.3	Linear Response.....	250
3.4	Fluctuation–Dissipation Theorem FDT.....	269
3.4.1	Correlation Function and Spectral Density.....	272
3.4.2	Van Hove Correlation Functions for Dynamic Scattering	275
3.4.3	Differential and Integral Forms of the FDT	278
3.4.4	Equilibrium or Nonequilibrium?	278
3.4.5	ω Identity of the FDT	279
3.4.6	Mathematical Background	280
3.4.7	Stochastic Derivation of the FDT.....	283
3.4.8	Quantum Aspects	288
3.4.9	Thermodynamic Consequences: Subtleties of the Second Law.....	290
3.5	Discussion of Functional Independence	293
3.6	Levy Distribution	297
4.	Slowing Down Mechanisms	313
4.1	Mode Coupling.....	314
4.2	Activated Rate Processes	321
4.3	Fluctuating Free Volume. Glarum–Levy Defects	326
4.4	Fischer Modes	344
4.5	Modifications Due to Partial Freezing-in.....	350
4.5.1	Preparation Time, Glass Frequency, and Vitrification Rate.....	350
4.5.2	Narayanaswamy Mixing	355
4.5.3	Example: Kovacs Expansion Gap	360
4.5.4	Struik Law of Physical Aging	362
5.	Epilogue	367
5.1	Ten Questions	367
5.2	Control of T_g	371

6. Conclusion	377
A. Synonyms	381
B. List of New Concepts	383
C. Acronyms	387
References	389
Index	411