

PHYSICAL REVIEW
AND
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INDEX

VOLUMES 21 AND 22

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JANUARY-DECEMBER 1980

PHYSICAL REVIEW
AND
PHYSICAL REVIEW LETTERS

INDEX

Including

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PHYSICAL REVIEW **AND** **PHYSICAL REVIEW LETTERS** **INDEX**

JANUARY - DECEMBER 1980

INTRODUCTION

As with last year's Index, this combined volume once again covers a full year of journal publications. The compilation of entries was prepared by the American Physical Society editorial staff from the computerized data base system developed in the journals' Editorial Office using the UNIX* system.

Entries under each author or subject heading are listed in the following order: Physical Review Letters, Physical Review A, B, C, D. Entries for each journal are listed in ascending order of volume and page number. For articles in Physical Review B and D, a small (1) or (15) at the end of the entry indicates that the article appeared in an issue dated the 1st or 15th of the month, respectively. The abbreviation (CA) appearing in an entry represents a Comment, Communication, or Addendum; the abbreviation (E) represents an Erratum.

In the Author Index a full listing occurs under the name of the first author only. Other author entries list the volume and page of the publication and direct the reader to the first-author entry. Authors who have used more than one version of their names are listed under the most complete version, in those cases where we could unambiguously determine that the names identified the same author. Every author is again strongly urged to select one form of his name and to use this consistently.

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PHYSICAL REVIEW AND PHYSICAL REVIEW LETTERS INDEX

THIRD SERIES, VOLUMES 21 AND 22

JANUARY-DECEMBER 1980

Subject Index

Papers are indexed under the following headings, which are a subset of the 1977 version of PACS. Only those headings which are relevant to papers published in *The Physical Review* and *Physical Review Letters* are listed.

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02. Mathematical methods in physics

- 02.10. + w Algebra, set theory, and graph theory
- 02.20. + b Group theory (for algebraic methods in quantum mechanics, see 03.65.F; for symmetries in elementary particle physics, see 11.30)
- 02.30. + g Function theory, analysis
- 02.40. + m Geometry, differential geometry, and topology (see also 04 Relativity and gravitation)
- 02.50. + s Probability theory, stochastic processes, and statistics (see also 05 Statistical physics)
- 02.60. + y Numerical approximation and analysis
- 02.70. + d Computational techniques (for data handling and computation, see 06.50)
- 02.90. + p Other topics in mathematical methods in physics

03. Classical and quantum physics: mechanics and fields

- 03.20. + i Classical mechanics of discrete systems: general mathematical aspects (for applied classical mechanics of discrete systems, see 46.10; for celestial mechanics, see 95.10.C)
- 03.30. + p Special relativity
- 03.40. - t Classical mechanics of continuous media: general mathematical aspects
- 03.40. Dz Mathematical theory of elasticity (see also 46.20 Continuum mechanics, and 46.30 Mechanics of solids)
- 03.40. Gc Fluid dynamics: general mathematical aspects (see also 47 Fluid dynamics)

- 03.40. Kf Waves and wave propagation: general mathematical aspects (see also 46.30.M Mechanical and elastic waves, 43.20 General linear acoustics)
- 03.50. - z Classical field theory
- 03.50. De Maxwell theory: general mathematical aspects (for applied classical electrodynamics, see 41)
- 03.50. Kk Other special classical field theories
- 03.65. - w Quantum theory; quantum mechanics (see also 05.30 Quantum statistical mechanics)
- 03.65. Bz Foundations, theory of measurement, miscellaneous theories
- 03.65. Ca Formalism
- 03.65. Db Functional analytical methods
- 03.65. Fd Algebraic methods (see also 02.20 Group theory, 33.10.C Computational methods in molecular spectroscopy)
- 03.65. Gc Solutions of wave equations: bound states
- 03.65. Nk Nonrelativistic scattering theory
- 03.65. Sq Semiclassical theories and applications
- Relativistic wave equations, see 11.10.Q
- 03.70. + k Theory of quantized fields (see also 11.10 Field theory)
- 03.80. + r General theory of scattering (see also 11.20 S-matrix theory and 11.80 Relativistic scattering)

04. Relativity and gravitation

- Special relativity, see 03.30
- 04.20. - q General relativity (see also 02.40 Geometry and topology)
- 04.20. Cv Fundamental problems and general formalism
- 04.20. Fy Canonical formalism, Lagrangians, and variational principles

- 04.20. Jb Solutions to equations
- 04.20. Me Conservation laws and equations of motion
- 04.30. + x Gravitational waves and radiation: theory
- 04.40. + c Continuous media; electromagnetic and other mixed gravitational systems
- 04.50. + h Unified field theories and other theories of gravitation
- 04.60. + n Quantum theory of gravitation
- Relativistic astrophysics, see 95.30.S
- Relativistic cosmology, see 98.80.D
- 04.80. + z Experimental tests of general relativity and observations of gravitational radiation
- 04.90. + e Other topics in relativity and gravitation

05. Statistical physics and thermodynamics (see also 02.50 Probability theory, stochastic processes, and statistics)

- 05.20. - y Statistical mechanics
- 05.20. Dd Kinetic theory
- 05.20. Gg Classical ensemble theory
- 05.30. - d Quantum statistical mechanics (see also 67 Quantum fluids and 71 Electron states in condensed matter)
- 05.30. Ch Quantum ensemble theory
- 05.30. Fk Fermion systems and electron gas
- 05.30. Jp Boson systems
- 05.40. + j Fluctuation phenomena, random processes, and Brownian motion
- 05.50. + q Lattice theory and statistics; Ising problems (see also 64.60.C Order-disorder and statistical mechanics of model systems; 75.10.H Ising models)

- 05.60.+w** Transport processes: theory
- 05.70.—a** Thermodynamics (see also 64 Equations of state, phase equilibria, and phase transitions, and 65 Thermal properties of condensed matter; for chemical thermodynamics, see 82.60)
- 05.70.Ce** Thermodynamic functions and equations of state
- 05.70.Fh** Phase transitions: general aspects
- 05.70.Jk** Critical point phenomena
- 05.70.Ln** Nonequilibrium thermodynamics, irreversible processes (see also 31.70.F Potential energy surfaces, 82 Physical chemistry)
- 05.90.+m** Other topics in statistical physics and thermodynamics
- 06. Measurement science, general laboratory techniques, and instrumentation systems**
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- 06.20.Hq** Measurement standards
- 06.20.Jr** Determination of fundamental constants
- 06.30.—k** Measurement of basic quantities
- 06.30.Bp** Measurement of spatial dimensions
- 06.50.—x** Data handling and computation
- 06.50.Dc** Data gathering, processing, and recording; data displays (including digital techniques)
- 06.70.—h** General instrumentation
- 06.70.Td** Servo and control devices
- 06.90.+v** Other topics in measurement science, general laboratory techniques, and instrumentation systems
- 07. Specific instrumentation and techniques of general use in physics** (see also within each subdiscipline for specialized instrumentation and techniques)
- 07.20.—n** Thermal instruments and techniques
- 07.20.Mc** Cryogenics
- 07.58.+g** Magnetic resonance spectrometers, auxiliary instruments, and techniques (see also 61.16.H EPR and NMR determinations)
- 07.60.—j** Optical instruments and techniques (for radiation detection, see 07.62; for spectroscopy and spectrometers, see 07.65; for optical lens and mirror systems, see 42.78; for optical devices, techniques, and applications, see 42.80)
- 07.60.Fs** Polarimetry and ellipsometry
- 07.60.Ly** Interferometers and Interferometry
- 07.62.+s** Detection of radiation (bolometers, photoelectric cells, infrared and submillimeter wave detection)
- 07.65.—b** Optical spectroscopy and spectrometers (see also 07.85 X-ray spectroscopy)
- 07.65.Eh** Visible and ultraviolet spectroscopy and spectrometers
- 07.75.+h** Mass spectrometers and mass spectrometry techniques
- Radiation spectrometers and spectroscopic techniques, see 29.30
- Radiation measurement, detection, and counting, see 29.70
- 07.85.+n** X- and γ -ray instruments and techniques

10. THE PHYSICS OF ELEMENTARY PARTICLES AND FIELDS

(FOR COSMIC RAYS, SEE 94.40; FOR EXPERIM. METHODS AND INSTRUMENTATION, SEE 29)

- 11. General theory of fields and particles** (see also 03.65 Quantum theory, 03.70 Theory of quantized fields, 03.80 General theory of scattering)
- 11.10.—z** Field theory
- 11.10.Ef** Lagrangian and Hamiltonian approach
- 11.10.Gh** Renormalization
- 11.10.Jj** Asymptotic problems and properties
- 11.10.Lm** Nonlinear or nonlocal theories and models
- 11.10.Mn** Schwinger source theory
- 11.10.Np** Gauge field theories
- 11.10.Qr** Relativistic wave equations
- 11.10.St** Bound and unstable states; Bethe-Salpeter equations
- 11.20.—e** S-matrix theory
- 11.20.Dj** Scattering matrix and perturbation theory
- 11.20.Fm** Dispersion relations and analytic properties of the S matrix
- 11.30.—j** Symmetry and conservation laws (see also 02.20 Group theory)
- 11.30.Cp** Lorentz and Poincaré invariance
- 11.30.Er** Charge conjugation, parity, time reversal, and other discrete symmetries
- 11.30.Jw** SU(2) and SU(3) symmetries
- 11.30.Kx** SU(4) symmetry
- 11.30.Ly** Other internal and higher symmetries
- 11.30.Na** Nonlinear and dynamical symmetries (spectrum-generating symmetries)
- 11.30.Pb** Supersymmetry
- 11.30.Qc** Spontaneous symmetry breaking
- 11.30.Rd** Chiral symmetries
- 11.40.—q** Currents and their properties
- 11.40.Dw** General theory of currents
- 11.40.Fy** Lagrangian approach to current algebras
- 11.40.Ha** Partially conserved axial-vector currents
- 11.50.—w** Dispersion relations and sum rules
- 11.50.Ec** N/D method
- 11.50.Jg** Crossing symmetries
- 11.50.Li** Sum rules
- 11.50.Nk** Multivariable dispersion relations (including Mandelstam representation)
- 11.60.+c** Complex angular momentum; Regge formalism (see also 03.80 General theory of scattering, 12.40.M—in strong interactions)
- 11.80.—m** Relativistic scattering theory (see also 03.80 General theory of scattering)
- 11.80.Cr** Kinematical properties (helicity and invariant amplitudes, kinematic singularities, etc.)
- 11.80.Et** Partial-wave analysis
- 11.80.Fv** Approximations (eikonal approximation, variational principles, etc.)
- 11.80.Gw** Multichannel scattering
- 11.80.Jy** Many-body scattering and Faddeev equation
- 11.80.La** Multiple scattering
- 11.90.+t** Other topics in general field and particle theory
- 12. Specific theories and interaction models; particle systematics**
- 12.20.—m** Electromagnetic and unified gauge fields
- 12.20.Ds** Specific calculations and limits of quantum electrodynamics
- 12.20.Fv** Experimental tests of quantum electrodynamics
- 12.20.Hx** Unified field theories and models
- 12.25.+e** Models for gravitational interactions (see also 04.60 Quantum theory of gravitation)
- 12.30.—s** Models of weak interactions
- 12.30.Cx** Neutral currents
- 12.30.Ez** Intermediate bosons
- 12.40.—y** Models of strong interactions
- 12.40.Bb** Composite models of the structure of hadrons (general models, dynamics, schemes for confinement)

- 12.40.Cc Properties of hadrons derived from the composite models
 12.40.Ee Statistical models
 12.40.Ff Bootstrap models
 12.40.Hh Duality and dual models
 12.40.Kj Hadron classification schemes
 12.40.Mm Complex angular momentum plane; Regge poles and cuts (Reggeons) (see also 11.60—for general theory)
 12.40.Pp Absorptive, optical, and eikonal models (for diffraction and diffractive production models, see 12.40.S)
 12.40.Qq Potential models
 12.40.Rr' Peripheral models (one or more particle exchange)
 12.40.Ss Multiperipheral and multi-Regge models (including diffraction and diffractive production models)
 12.40.Vv Vector-meson dominance
 12.70.+q Hadron mass formulas
 12.90.+b Miscellaneous theoretical ideas and models

13. Specific reactions and phenomenology

- 13.10.+q Weak and electromagnetic interactions of leptons (including interactions involving cosmic rays)
 13.15.+g Neutrino interactions (including reactions involving cosmic rays)
 13.20.—v Leptonic and semileptonic decays of mesons
 13.20.Cz π decays
 13.20.Eb K decays
 13.20.Jf Other meson decays (including the charmed mesons: ψ , J , etc.)
 13.25.+m Hadronic decays of mesons
 13.30.—a Decays of baryons
 13.30.Ce Leptonic and semileptonic decays

- 13.30.Eg Hadronic decays
 13.40.—f Electromagnetic processes and properties of hadrons
 13.40.Dk Electromagnetic mass differences
 13.40.Fn Electromagnetic form factors; electric and magnetic moments
 13.40.Hq Electromagnetic decays
 13.40.Ks Electromagnetic corrections to strong- and weak-interaction processes
 13.60.—r Photon and charged-lepton interactions with hadrons (for neutrino interactions, see 13.15)
 13.60.Fz Elastic and Compton scattering
 13.60.Hb Total and inclusive cross sections (including deep-inelastic processes)
 13.60.Kd Meson production
 13.60.Mf Meson-resonance production
 13.60.Rj Baryon and baryon-resonance production
 13.65.+i Hadron production by electron-positron collisions
 13.75.—n Hadron-induced low- and intermediate-energy reactions and scattering, energy ≤ 10 GeV (for higher energies, see 13.85)
 13.75.Cs Nucleon-nucleon interactions (including antinucleons, deuterons, etc.; energy ≤ 10 GeV) (for N - N interactions in nuclei, see 21.30)
 13.75.Ev Hyperon-nucleon interactions (energy ≤ 10 GeV)
 13.75.Gx Pion-baryon interactions (energy ≤ 10 GeV)
 13.75.Jz Kaon-baryon interactions (energy ≤ 10 GeV)
 13.75.Lb Meson-meson interactions (energy ≤ 10 GeV)
 13.85.—t Hadron-induced high- and super-high-energy interactions (energy > 10 GeV) (for low energies, see 13.75)

- 13.85.Dz Elastic scattering (energy > 10 GeV)
 13.85.Fb Inelastic scattering: two-particle final states (energy > 10 GeV)
 13.85.Hd Inelastic scattering: many-particle final states (energy > 10 GeV)
 13.85.Kf Inclusive reactions, including total cross sections (energy > 10 GeV)
 13.85.Mh Cosmic ray interactions (energy > 10 GeV) (see also 94.40 Cosmic rays)
 13.90.+i Other topics in specific reactions and phenomenology of elementary particles

14. Properties of specific particles and resonances

- 14.20.—c Baryons and baryon resonances (including antiparticles)
 14.20.Cg Neutrons
 14.20.Ei Protons
 14.20.Gk Baryon resonances with $S = 0$
 14.20.Jn Hyperons and hyperon resonances
 14.40.—n Mesons and meson resonances
 14.40.Dt π mesons
 14.40.Fw K mesons
 14.40.Ka ρ , ω , and η mesons
 14.40.Mc A and B mesons
 14.40.Pe Other heavy mesons (including the charmed mesons: ψ , J , etc.)
 14.60.—z Leptons
 14.60.Cd Electrons and positrons
 14.60.Ef Muons
 14.60.Gh Neutrinos
 14.80.—j Other and hypothetical particles
 14.80.Dq Quarks
 14.80.Fs Intermediate bosons
 14.80.Hv Magnetic monopoles
 14.80.Kx Others (including photons and tachyons)

20. NUCLEAR PHYSICS

21. Nuclear structure

- 21.10.—k General and average properties of nuclei; properties of nuclear energy levels (for properties of specific nuclei listed by mass ranges, see 27)
 21.10.Dr Binding energy and masses
 21.10.Ft Shape, charge, and radius
 21.10.Hw Spin, parity, and isobaric spin
 21.10.Jx Spectroscopic factors
 21.10.Ky Electromagnetic moments
 21.10.Ma Level density and structure
 21.10.Pc Single-particle structure in levels
 21.10.Re Collective structure in levels (including rotational bands)
 21.10.Sf Coulomb effects
 21.30.+y Nuclear forces (see also 13.75.C Nucleon-nucleon interactions)
 21.40.+d Few-nucleon systems

- 21.60.—n Nuclear-structure models and methods
 21.60.Cs Shell model
 21.60.Ev Collective models
 21.60.Fw Models based on group theory
 21.60.Gx Cluster models
 21.60.Jz Hartree-Fock and random-phase approximations
 21.65.+f Nuclear matter
 Exotic atoms and molecules, see 36.10
 21.80.+a Hypernuclei
 21.90.+f Other topics in nuclear structure

23. Nuclear decay and radioactivity (see also 82.55 Radiochemistry)

- 23.20.—g Electromagnetic transitions
 23.20.Ck Lifetimes and transition probabilities

- 23.20.En Angular distribution and correlation measurements
 23.20.Gq Multipole mixing ratios
 23.20.Js Multipole matrix elements
 23.20.Lv Gamma transitions and level energies
 23.20.Nx Internal conversion and extranuclear effects
 23.40.—s β decay; electron and muon capture
 23.40.Bw Weak interaction and lepton aspects of β decay
 23.40.Hc Nuclear matrix elements and nuclear structure inferred from β decay
 23.60.+e α decay
 23.90.+w Other topics in nuclear decay and radioactivity

24. Nuclear reactions and scattering: general

- 24.10.-i Nuclear reaction and scattering models and methods
- 24.10.Dp Coupled-channel and many-body-theory methods
- 24.10.Fr Plane- and distorted-wave Born approximations
- 24.10.Ht Optical and diffraction models
- 24.30.-v **Resonance reactions and scattering**
- 24.30.Cz Giant resonances
- 24.30.Eb Isobaric analog resonances
- 24.50.+g Direct reactions and scattering
- 24.60.+m Statistical theory and fluctuations
- 24.70.+s Polarization in reactions and scattering
- 24.75.+i General properties of fission
- 24.90.+j Other topics in nuclear reactions and scattering: general

25. Nuclear reactions and scattering: specific reactions

- 25.10.+s Nuclear reactions and scattering involving few-nucleon systems
- 25.20.+y Photonuclear reactions and photon scattering
- 25.30.-c Lepton-induced reactions and scattering
- 25.30.Cg Electron and positron scattering
- 25.30.Ei Muon scattering
- 25.30.Gk Neutrino scattering
- 25.40.-h Nucleon-induced reactions and scattering (see also 28.20 Neutron physics)
- 25.40.Cm Elastic proton scattering
- 25.40.Dn Elastic neutron scattering
- 25.40.Ep Inelastic proton scattering and (p, n) reactions
- 25.40.Fq Inelastic neutron scattering and (n, p) reactions

- 25.40.Gr Single-nucleon transfer reactions
- 25.40.Jt Few-nucleon transfer reactions
- 25.40.Lw Radiative capture
- 25.40.Rb Reactions and scattering above meson production thresholds (energies > 400 MeV)
- 25.50.-n **^2H - and ^3H -induced reactions and scattering**
- 25.50.Dt Elastic and inelastic scattering
- 25.50.Gx Single-nucleon transfer reactions
- 25.50.Jz Few-nucleon transfer reactions

- 25.60.-t **^3He - and ^4He -induced reactions and scattering**
- 25.60.Cy Elastic and inelastic scattering
- 25.60.Ea Single-nucleon transfer reactions
- 25.60.Fb Few-nucleon transfer reactions

- 25.70.-z **Heavy-particle-induced reactions and scattering**
- 25.70.Bc Reaction mechanisms
- 25.70.De Few-nucleon transfers
- 25.70.Fg Bulk matter and collective aspects of heavy-ion reactions
- 25.70.Hi Elastic, inelastic, and charge exchange reactions
- 25.70.Kk Coulomb excitation

25.80.+f Meson- and hyperon-induced reactions and scattering

- 25.85.-w **Fission reactions**
- 25.85.Ca Spontaneous fission
- 25.85.Ec Neutron-induced fission
- 25.85.Ge Charged-particle-induced fission
- 25.85.Jg Photofission
- 25.90.+k Other topics in nuclear reactions and scattering: specific reactions

27. Properties of specific nuclei listed by mass ranges (an additional heading must be chosen with these entries, where the given mass number limits are, to some degree, arbitrary)

- 27.10.+h $A \leq 5$
- 27.20.+n $6 \leq A \leq 19$

- 27.30.+t $20 \leq A \leq 38$
- 27.40.+z $39 \leq A \leq 58$
- 27.50.+e $59 \leq A \leq 89$
- 27.60.+j $90 \leq A \leq 149$
- 27.70.+q $150 \leq A \leq 189$
- 27.80.+w $190 \leq A \leq 219$
- 27.90.+b $220 \leq A$

28. Nuclear engineering and nuclear power studies

- 28.20.-v Neutron physics (see also 25.40 Nucleon-induced reactions and scattering)
- 28.20.Fc Neutron absorption
- 28.60.+s Isotope separation and enrichment

29. Experimental methods and instrumentation for elementary-particle and nuclear physics

- 29.15.-n Electrostatic, collective, and linear particle accelerators
- 29.30.-h Radiation spectrometers and spectroscopic techniques
- 29.30.Ep α -ray spectroscopy
- 29.40.-n Radiation detectors
- 29.40.Ka Cherenkov detectors
- 29.40.Rg Nuclear emulsions
- 29.70.-e Radiation measurement, detection, and counting (see also 29.30 Radiation spectrometers and spectroscopy, 29.40 Radiation detectors)
- 29.70.Gn Energy loss and energy range relations
- 29.90.+r Other topics in elementary-particle and nuclear physics experimental methods and instrumentation

30. ATOMIC AND MOLECULAR PHYSICS (FOR PHYSICAL CHEMISTRY, SEE 82)**31. Electronic structure of atoms and molecules: theory (see also 71 Electron states in condensed matter)**

- 31.10.+z General theory of electronic structure, electronic transitions, and chemical binding
- 31.15.+q General mathematical and computational developments
- 31.20.-d **Specific calculations and results**
- 31.20.Di Complete *ab initio* calculations (exact or nearly exact calculations on small species)
- 31.20.Ej *Ab initio* LCAO and GO SCF calculations
- 31.20.Gm Other accurate, or nearly *ab initio* calculations (DIM method, SAMO method, etc.)

- 31.20.Lr Statistical model calculations (Thomas-Fermi and Thomas-Fermi Dirac models)
- 31.20.Pv Other semi-empirical calculations (Huckel generalized Huckel, PPP methods, etc.)
- 31.20.Rx Valence bond calculations (*ab initio* or not)
- 31.20.Tz Electron correlation and CI calculations
- 31.20.Wb Empirical methods (nonquantum methods for conformations, as Wiberg method, Westheimer method, etc.)
- 31.30.-i **Corrections to electronic structure**
- 31.30.Gs Hyperfine interactions and isotope effects

- 31.30.Jv Radiative and relativistic effects
- 31.50.+w **Excited states**
- 31.70.-f **Effects of molecular interactions on electronic structure (see also 34 Atomic and molecular collision processes and interactions)**
- 31.70.Hq Time-dependent phenomena: excitation and relaxation processes, and reaction rates (see also 34 Atomic and molecular collision processes and interactions)
- 31.90.+s **Other topics in the theory of the electronic structure of atoms and molecules (including properties other than the energy)**

32. Atomic spectra and interactions with photons

- 32.30.—r** Atomic spectra, grouped by wavelength ranges
- 32.30.Bv** Radiofrequency, microwave, and infrared spectra (including magnetic resonance spectra)
- 32.30.Jc** Visible and ultraviolet spectra (*for fluorescence and phosphorescence spectra, see 32.50*)
- 32.30.Rj** X-ray spectra
- 32.50.+d** Fluorescence, phosphorescence (including quenching) (*for quenching processes, see also 34.*)
- 32.60.+i** Zeeman and Stark effects
- 32.70.—n** Intensities and shapes of atomic spectral lines
- 32.70.Cs** Oscillator strengths, transition moments
- 32.70.Fw** Lifetimes, absolute and relative intensities
- 32.70.Jz** Line shapes, widths, and shifts
- 32.80.—t** Photon interactions with atoms
- 32.80.Bx** Level crossing and optical pumping
- 32.80.Dz** Autoionization
- 32.80.Fb** Photoionization and photodetachment
- 32.80.Hd** Auger effect and inner-shell ionization
- 32.80.Kf** Multiphoton processes
- 32.90.+a** Other topics in atomic spectra and interactions of atoms with photons

33. Molecular spectra and interactions of molecules with photons

- 33.10.—n** Calculation of molecular spectra
- 33.10.Cs** Computational methods (including new theoretical techniques and applications of group theory) (*see also 03.65.F Algebraic methods in quantum mechanics*)
- 33.10.Ev** Rotational analysis
- 33.10.Gx** Vibrational analysis
- 33.10.Jz** Vibration-rotational analysis
- 33.10.Lb** Vibronic, rovibronic, and rotation-electron-spin interactions
- 33.20.—t** Molecular spectra, grouped by wavelength ranges (*for photoelectron spectra, see 33.60*)
- 33.20.Bx** Radio-frequency and microwave spectra (*for NMR spectra, see 33.25; for EPR spectra, see 33.35*)
- 33.20.Ea** Infrared spectra
- 33.20.Fb** Raman and Rayleigh spectra (including optical scattering)
- 33.20.Kf** Visible spectra
- 33.20.Lg** Ultraviolet spectra
- 33.20.Rm** X-ray spectra
- 33.25.—j** Nuclear magnetic resonance (NMR) and relaxation
- 33.25.Bn** Relaxation phenomena
- 33.25.Dq** Chemical shifts
- 33.25.Fs** Nuclear spin interactions and quadrupole effects

- 33.35.—q** Electron paramagnetic resonance (EPR) and relaxation
- 33.35.Cv** Relaxation phenomena
- 33.45.+x** Mossbauer spectra
- 33.50.—j** Fluorescence and phosphorescence; radiationless transitions (intersystem crossing, internal conversion) (*for quenching processes, see also 34*)
- 33.50.Dq** Fluorescence and phosphorescence spectra
- 33.50.Hv** Radiationless transitions
- 33.55.+c** Zeeman and Stark effects; magneto-optical and electro-optical spectroscopy; circular dichroism
- 33.60.—q** Photoelectron spectra
- 33.60.Cv** Ultraviolet and vacuum-ultraviolet photoelectron spectra
- 33.60.Fy** X-ray photoelectron spectra
- 33.70.—w** Intensities and shapes of molecular spectral lines and bands
- 33.70.Ca** Oscillator and band strengths, transition moments, and Franck-Condon factors
- 33.70.Fd** Lifetimes, absolute and relative line and band intensities
- 33.70.Jg** Line and band widths, shapes, and shifts
- 33.80.—b** Photon interactions with molecules
- 33.80.Eh** Autoionization, photoionization, and photodetachment
- 33.80.Gj** Diffuse spectra; predissociation, photodissociation
- 33.80.Kn** Multiphoton processes
- 33.90.+h** Other topics in molecular spectra and molecular interactions with photons

34. Atomic and molecular collision processes and interactions

- 34.10.+x** General theories and models (including statistical theories, transition state, stochastic and trajectory models, etc.)
- 34.20.—b** Interatomic and intermolecular potentials and forces
- 34.20.Be** General potential functions and intermediate-range forces (*see also 31.70.F and 82.20.K for potential energy surfaces*)
- 34.20.Fi** Long-range forces
- 34.20.Kn** Short-range forces
- 34.40.+n** Elastic scattering of atoms and molecules
- 34.50.—s** Inelastic scattering of atoms and molecules
- 34.50.Ez** Rotational and vibrational energy transfer
- 34.50.Hc** Electronic excitation and ionization (including beam-foil excitation and ionization)
- 34.50.Lf** Chemical reactions, energy disposal, and angular distribution, as studied by atomic and molecular beams (*see also 31.70.F and 82.20.K for potential-energy surfaces, 82.40.D Beam reactions*)

- 34.70.+e** Charge transfer (*see also 82.30.F Charge transfer reactions*)
- 34.80.—i** Electron scattering
- 34.80.Bm** Elastic scattering of electrons by atoms and molecules
- 34.80.Dp** Atomic excitation and ionization by electron impact
- 34.80.Gs** Molecular excitation, ionization, and dissociation by electron impact
- 34.90.+q** Other topics in atomic and molecular collision processes and interactions

35. Experimentally derived information on atoms and molecules; instrumentation and techniques

- 35.10.—d** Atoms
- 35.10.Bg** Atomic masses, mass spectra, abundances, and isotopes (*for mass spectrometry, see also 07.75*)
- 35.10.Di** Electric and magnetic moments, polarizability
- 35.10.Fk** Relativistic corrections, fine- and hyperfine-structure constants
- 35.10.Hn** Ionization potentials, electron affinities
- 35.20.—i** Molecules (*see also 61.55, 61.60, and 61.65 for specific structures of elements and alloys, of other inorganic materials, and of organic materials, respectively*)
- 35.20.Bm** General molecular conformation and symmetry; stereochemistry
- 35.20.Dp** Interatomic distances and angles
- 35.20.Gs** Bond strengths, dissociation energies, hydrogen bonding, etc.
- 35.20.My** Electric and magnetic moments (and derivatives), polarizability, and magnetic susceptibility
- 35.20.Pa** Rotation, vibration, and vibration-rotation constants
- 35.20.Sd** Hyperfine- and fine-structure constants
- 35.20.Vf** Ionization potentials, electron affinities, molecular core binding energy
- 35.20.Yh** Correlation times in molecular dynamics
- 35.80.+s** Atomic and molecular measurement and techniques

36. Studies of special atoms and molecules

- 36.10. k** Exotic atoms and molecules (containing mesons, muons, and other abnormal particles)
- 36.10.Dr** Positronium, muonium, muonic atoms and molecules
- 36.10.Gv** Mesonic atoms and molecules, hyperonic atoms and molecules
- 36.20.—r** Macromolecules and polymer molecules (*for polymer reactions and polymerization, see 82.35; for biological macromolecules and polymers, see also 87.15*)
- 36.40.+d** Atomic and molecular clusters
- 36.90.+f** Other special atoms and molecules

40. CLASSICAL AREAS OF PHENOMENOLOGY (INCLUDING APPLICATIONS)

- 41. Electricity and magnetism: fields and charged particles**
- 41.10.—j **Classical electromagnetism**
..... *Maxwell theory, see 03.50.D*
- 41.10.Dq Electrostatics, magnetostatics
- 41.10.Hv Electromagnetic waves: theory
- 41.70.+t **Particles in electromagnetic fields: classical aspects (including synchrotron radiation)**
- 41.80.—y **Particle beams and particle optics**
(*see also 07.77 Particle beam production and handling, 07.80 Electron and ion microscopes and techniques*)
- 41.80.Dd Electron beams and electron optics
- 42. Optics** (*for properties of gases and of liquids and solids see 51.70 and 78, respectively*)
- 42.10.—s **Propagation and transmission in homogeneous media**
- 42.10.Fa Edge and boundary effects, refraction
- 42.10.Mg Coherence
- 42.10.Qj Propagation and transmission in homogeneous and anisotropic media; birefringence
- 42.20.—y **Propagation and transmission in inhomogeneous media**
- 42.20.Gg Scattering from haze, fog, dust, etc. (*see also 42.68 Atmospheric optics*)
- 42.40.—i **Holography**
- 42.40.Kw Holographic instrumentation and techniques
- 42.50.+q **Quantum optics**
- 42.55.—f **Lasing processes**
- 42.55.Bi General theory of lasing action
- 42.55.Fn Inert gas lasers
- 42.60.—v **Laser systems and laser beam applications**
- 42.60.By Design of specific laser systems
- 42.60.Da Laser resonators and cavities
- 42.60.Fc Laser beam modulation
- 42.60.He Optical problems related to properties and interactions of laser beams
- 42.60.Kg Optical problems related to applications of laser beams
- 42.65.—k **Nonlinear optics**
- 42.65.Bp General theory
- 42.65.Cq Stimulated Raman, Brillouin, and Rayleigh scattering; parametric oscillations and harmonic generation
- 42.65.Gv Photon echoes, self-induced transparency, optical saturation, and related effects
- 42.65.Jx Beam trapping, self focusing, thermal blooming, and related effects
- 42.68.—w **Atmospheric optics**
- 42.68.Vs Clouds, fog, haze, aerosols; effects of air pollution
- 42.70.—a **Optical materials**
- 42.70.Gi Light-sensitive materials
- 42.80.—f **Optical devices, techniques, and applications**
- 42.80.Fn Gratings, échelles
- 42.80.Mv Fiber optics
- 42.80.Sa Optical communication devices
- 43. Acoustics** (*for more detailed headings, see Appendix, Sec. 43*)
- 43.20.+g **General linear acoustics** (*see also 03.40.K Mathematical problems in waves and wave propagation*)
- 43.25.+y **Nonlinear acoustics and macrosonics**
- 43.35.+d **Ultrasonics, quantum acoustics, and physical effects of sound**
..... *Phonons in crystal lattices, see 63.20*
..... *Plasma acoustics, see 52.35*
..... *Low-temperature acoustics and sound in liquid helium, see 67*
..... *Acoustical properties of solids, see 62.65; for ultrasonic relaxation, see 62.80*
..... *Acoustical properties of thin films, see 68.60*
..... *Surface waves in solids and liquids, see 68.10 and 68.25*
..... *Acoustoelectric effects and acoustic wave amplification, see 72.50*
..... *Magnetoacoustic effects, oscillations, and resonance, see 72.55 and 75.80*
..... *Acoustic holography, see 43.63; for acousto-optical effects, see 78.20.H*
- 43.60.+d **Acoustic signal processing**
..... *Bioacoustics, see 87.50.C*
- 43.85.+f **Acoustical measurements and instrumentation**
- 44. Heat flow, thermal and thermodynamic processes**
- 44.90.+c **Other topics in heat flow, thermal and thermodynamic processes**
- 46. Mechanics, elasticity, rheology**
- 46.20.+e **Continuum mechanics** (*see also 03.40 —mathematical aspects*)
- 46.30.—i **Mechanics of solids and rheology**
(*see also 62.20 Mechanical properties of solids, as related to microscopic structure*)
- 46.30.Jv Viscoelasticity, plasticity, viscoplasticity, creep, and stress relaxation (including rheology of solids)
- 47. Fluid dynamics**
- 47.10.+g **General theory** (*see also 03.40.G—General mathematical aspects*)
- 47.15.—x **Laminar flows**
- 47.20.+m **Hydrodynamic stability**
- 47.25.—c **Turbulent flows, convection, and heat transfer**
- 47.25.Cg Isotropic turbulence
- 47.25.Jn Turbulent diffusion
- 47.25.Qv Convection and heat transfer (*see also 44.25 Convective and constrained heat transfer*)
- 47.30.+s **Rotational flows and vorticity**
- 47.35.+i **Hydrodynamic waves**
- 47.55.—t **Nonhomogeneous flows**
- 47.60.+i **Flows in ducts, channels, and conduits**
..... *Biological fluid dynamics, see 87.45*
- 47.65.+a **Magnetohydrodynamics and electrohydrodynamics** (*for MHD in plasma, see 52.30*)
- 47.90.+a **Other topics in fluid dynamics**

50. FLUIDS, PLASMAS, AND ELECTRIC DISCHARGES

(FOR FLUID DYNAMICS, SEE 47; FOR CONDENSED MATTER, SEE 60 AND 70)

- 51. Kinetic and transport theory of fluids; physical properties of gases**
- 51.10.+y **Kinetic and transport theory**
- 51.20.+d **Viscosity and diffusion: experimental**
- 51.40.+p **Acoustical properties of gases; ultrasonic relaxation** (*see also 43 Acoustics; for liquids see 62.60 and 62.80*)
- 51.50.+v **Electrical phenomena in gases** (*see also 52 The physics of plasmas and electric discharges*)
- 51.60.+a **Magnetic phenomena in gases** (*for liquids, see 75*)
- 51.70.+f **Optical phenomena in gases** (*for liquids, see 78*)
- 51.90.+r **Other topics in the physics of fluids**

52. The physics of plasmas and electric discharges (for solid-state plasma, see 71.45.G and 72.30)

- 52.20. —j **Elementary processes in plasma**
 52.20.Dq Single-particle orbits
 52.20.Fs Electron collisions
 52.20.Hv Atomic, molecular, heavy-particle collisions
- 52.25. —b **Plasma basic properties**
 52.25.Dg Plasma kinetic equations
 52.25.Fi Transport properties
 52.25.Gj Fluctuation phenomena
 52.25.Kn Thermodynamics of plasmas
 52.25.Lp Temperature and density
 52.25.Mq Dielectric properties
 52.25.Ps Emission, absorption, and scattering of radiation
- 52.30. +r **Plasma flow; magnetohydrodynamics (see also 47.65—in fluid dynamics)**
- 52.35. —g **Waves, oscillations, and instabilities in plasma**
 52.35.Bj Magnetohydrodynamic waves
 52.35.Dm Sound waves
 52.35.Fp Electrostatic waves and oscillations

- 52.35.Hr Electromagnetic waves
 52.35.Kt Drift waves
 52.35.Mw Nonlinear waves and nonlinear interactions
 52.35.Py Plasma instabilities
 52.35.Ra Plasma turbulence
 52.35.Tc Shock waves
- 52.40. —w **Plasma interactions**
 52.40.Db Electromagnetic wave propagation in plasma
 52.40.Fd Antennas in plasma; plasma-filled wave guides
 52.40.Hf Solid-plasma interactions
 52.40.Kh Sheaths
 52.40.Mj Beam interactions in plasma
- 52.50. —b **Plasma production and heating**
 52.50.Dg Plasma sources (see also 52.80 Electric discharges)
 52.50.Gj Plasma heating
 52.50.Jm Plasma production and heating by laser beams
- 52.55. —s **Plasma equilibrium and confinement**
 52.55.Dy General theory
 52.55.Ez Pinch effect and pinch machines

- 52.55.Gb Plasma in torus (stellarator, tokamak, MS-torus, circulator, etc.)
 52.55.Ke Magnetic traps (e.g., astron, heliotron, mirror, cusp, etc.)
 52.55.Mg Nonmagnetic confinement systems (e.g., electrostatic and high-frequency confinement, etc.)
 52.55.Pi Confinement in fusion reactors (see also 28.50.R Fusion reactors)
- 52.60. +h **Relativistic plasma**
- 52.65. +z **Plasma simulation**
- 52.70. —m **Plasma diagnostic techniques and instrumentation**
 52.70.Ds Electric and magnetic measurements
 52.70.Gw Radio-frequency and microwave measurements
 52.70.Kz Optical measurements
 52.70.Nc Particle measurements
- 52.80. —s **Electric discharges (see also 51.50 Electrical phenomena in gases)**
 52.80.Hc Glow; corona
- 52.90. +z **Other topics in plasma physics and electric discharges**

60. CONDENSED MATTER: STRUCTURE, MECHANICAL AND THERMAL PROPERTIES

61. Structure of liquids and solids; crystallography (see also 68.20 Solid surface structures, 71. Electron states)

- 61.10. —i **X-ray determination of structures (for specific determinations, see 61.55 to 61.80)**
 61.10.Dp Theories of diffraction and scattering
 61.10.Fr Experimental techniques
- 61.12. —q **Neutron determination of structures (for specific determinations, see 61.55 to 61.80)**
 61.12.Dw Elastic neutron diffraction and scattering
 61.12.Fy Inelastic neutron diffraction and scattering
- 61.14. —x **Electron determination of structures (for specific determinations, see 61.55 to 61.80)**
 61.14.Dc Theories of diffraction and scattering
 61.14.Fe Experimental diffraction and scattering
 61.14.Hg Low-energy electron diffraction (LEED) and reflection high-energy electron diffraction (RHEED)
- 61.16. —d **Other determination of structures (for specific determinations, see 61.55 to 61.80)**
 61.16.Di Electron microscopy determinations

- 61.16.Fk Field-ion microscopy determinations
 61.16.Hn EPR and NMR determinations
- 61.20. —p **Classical, semiclassical, and quantum theories of liquid structure (for kinetic theory of fluid media, see 51.10; for liquid helium, see 67; for electronic states, see 71)**
 61.20.Gy Statistical theories of liquid structure
 61.20.Ja Computer simulation of static and dynamic behavior
 61.20.Lc Time-dependent properties
 61.20.Ne Structure of simple liquids
- 61.25. —f **Studies of specific liquid structures**
 61.25.Bi Liquid noble gases
 61.25.Em Molecular liquids
 61.25.Hq Macromolecular and polymer solutions (solubility, swelling, etc.)
 61.25.Mv Liquid metals
- 61.30. —v **Liquid crystals (see also 64.70.E Transitions in liquid crystals)**
 61.30.Cz Microstructure theory of liquid crystals
 61.30.Eb Experimental determinations of smectic, nematic, cholesteric, and lyotropic structures
 61.30.Gd Orientational order of liquid crystals in electric and magnetic fields
- 61.40. —a **Amorphous and polymeric materials**

- 61.40.Df Glasses (see also 81.20.P, 81.20.Q, and 81.60.F—in materials science)
 61.40.Km Polymers, elastomers, and plastics (see also 81.20.S, 81.20.T, and 81.60.J—in materials science)
- 61.50. —f **Crystalline state (including molecular motions in solids) (for magnetic structure and spin systems, see 75.25)**
 61.50.Cj Physics of crystal growth (for epitaxy of thin films, see 68.55; for whiskers, see 68.70; for techniques of crystal growth and film deposition, see 81.10 and 81.15)
- 61.50.Em Crystal symmetry: models, space groups, and crystalline systems and classes
 61.50.Jr Crystal morphology and orientation
 61.50.Ks Crystallographic aspects of polymorphic and order-disorder transformations
 61.50.Lt Crystal binding
- 61.55. —x **Specific structures of elements and alloys**
 61.55.Dc Nonmetallic elements
 61.55.Fe Metallic elements
 61.55.Hg Alloys
- 61.60. +m **Specific structures of inorganic compounds**
- 61.65. +d **Specific structures of organic compounds**

- 61.70.-r** Defects in crystals (*see also* 61.80 Radiation damage, 62 Mechanical and acoustical properties, 71.55 Impurities and defect levels, 76.30.M EPR of color centers and other defects, 78.50 Impurity and defect absorption in solids, 81.40 Treatment of materials)
- 61.70.Bv Interstitials and vacancies (excluding color centers)
- 61.70.Dx Color centers
- 61.70.Ey Other point defects
- 61.70.Ga Dislocations: theory
- 61.70.Jc Etch pits, decoration, transmission electron-microscopy, and other direct observations of dislocations
- 61.70.Le Slip, creep, internal friction, and other indirect evidence of dislocations (*see also* 62.20.H Creep, 62.40 Internal friction)
- 61.70.Ng Grain and twin boundaries
- 61.70.Ph Stacking faults, stacking fault tetrahedra, and other planar or extended defects
- 61.70.Rj Crystal impurities: general (*see also* 71.55 Impurity and defect levels, 81.10 Purification techniques)
- 61.70.Tm Doping and implantation of impurities
- 61.70.Wp Impurity concentration, distribution, and gradients (*see also* 66.30.J Diffusion, migration, and displacement of impurities)
- 61.70.Yq Interaction between different crystal structure defects
- 61.80.-x** Radiation damage and other irradiation effects (*for techniques of structure determination, see* 61.10 to 61.16; *for electron and ion impact phenomena, see* 79.20)
- 61.80.Cb X rays
- 61.80.Fe Electrons and positrons
- 61.80.Hg Neutrons
- 61.80.Jh Ions (*for ion implantation, see* 61.70.T)
- 61.80.Mk Channeling, blocking, and energy loss of particles (*see also* 29.70.G Energy loss and range relations)
- 61.90.+d** Other topics in structure of liquids and solids
- 62. Mechanical and acoustical properties of condensed matter** (*see also* 46.30 Mechanics of solids, 61.70 Defects in crystals, 68.25 Surfaces and interfaces, 81 Materials science)
- 62.10.+s** Mechanical properties of liquids (*for viscosity of liquids, see also* 66.20)
- 62.20.-x** Mechanical properties of solids (related to microscopic structure) (*see also* 81.40 Treatment of materials and its effects on microstructures and properties, 81.70 Materials testing)
- 62.20.Dc Elastic constants (*see also* 03.40.D Mathematical theory of elasticity, 81.40.J Elasticity and anelasticity)
- 62.20.Fe Deformation and plasticity (including yield, ductility, and superplasticity) (*see also* 81.40.L —in materials science)
- 62.20.Mk Fatigue, brittleness, fracture, and cracks (*see also* 81.40.N —in materials science)
- 62.30.+d** Mechanical and elastic waves (*see also* 03.40.K General mathematical aspects)
- 62.40.+i** Anelasticity, internal friction, and mechanical resonances (*see also* 81.40.J —in materials science)
- Thermomechanical effects, *see* 65.70
- Magnetomechanical effects, *see* 75.80
- Piezoelectric effects, *see* 77.60
- Elasto-optical effects, *see* 78.20.H
- 62.50.+p** High-pressure and shock-wave effects in solids
- 62.60.+v** Acoustical properties of liquids
- Sound propagation in liquids and solids, *see* 43
- Lattice dynamics, phonons, *see* 63
- Second sound in quantum fluids, *see* 67.40.P, 67.50, and 67.60
- 62.65.+k** Acoustical properties of solids
- Magnetoacoustic effects, *see* 72.55
- Acoustoelectric effects, *see* 72.50
- Acousto-optical effects, *see* 78.20.H
- 62.80.+f** Ultrasonic relaxation (*see also* 43.55 Ultrasonics; 74.30.G Ultrasonic attenuation in superconductors)
- 63. Lattice dynamics and crystal statistics** (*see also* 05.50 Lattice theory, 65 Thermal properties, 66.70 Thermal conduction, 68.30 Dynamics of surface and interface vibrations, 78.30 Infrared and Raman spectra)
- 63.10.+a General theory
- 63.20.-e Phonons and vibrations in crystal lattices
- 63.20.Dj Phonon states and bands, normal modes, and phonon dispersion
- 63.20.Hp Phonon-phonon interactions
- 63.20.Kr Phonon-electron interactions
- 63.20.Mt Phonon-defect interactions
- 63.20.Pw Localized modes
- 63.50.+x Vibrational states in disordered systems
- 63.70.+h** Statistical mechanics of lattice vibrations (*see also* 65 Thermal properties of condensed matter, and 66.70. Thermal conduction)
- 63.75.+z Statistical mechanics of dispersive phase transitions
- Order-disorder and statistical mechanics of model systems, *see* 64.60.C
- Crystallographic aspects of polymorphic and order-disorder transformations, *see* 61.50.K
- 63.90.+t** Other topics in lattice dynamics and crystal statistics
- 64. Equations of state, phase equilibria, and phase transitions** (*see also* 82.60 Chemical thermodynamics)
- 64.10.+h** General theory of equations of state and phase equilibria
- 64.30.+t** Equations of state of specific substances (*see also* 65.70 Thermal expansion)
- 64.60.-i** General studies of phase transitions (*for critical phenomena in quantum fluids, see* 67; *for critical phenomena in superconductors, see* 74.40; *for critical phenomena in magnetic materials, see* 75.40)
- 64.60.Cn Order-disorder and statistical mechanics of model systems
- 64.60.Fr Equilibrium properties near single critical points, critical exponents
- 64.60.Ht Dynamic critical phenomena
- 64.60.Kw Multicritical points
- 64.60.My Metastable phases
- 64.70.-p** Phase equilibria, phase transitions, and critical points of specific substances (*see also* 81.30 Phase diagrams and microstructures developed by solidification and solid-solid phase transformations)
- 64.70.Dv Solid-liquid transitions
- 64.70.Ew Transitions in liquid crystals; glass transitions
- 64.70.Fx Liquid-vapor transitions
- 64.70.Hz Solid-vapor transitions
- 64.70.Ja Liquid-liquid transitions
- 64.70.Kb Solid-solid transitions (*see also* 61.50.K Crystallographic aspects of polymorphic and order-disorder transformations)
- 64.75.+g** Solubility, segregation, and mixing
- 64.80.-v** Other phase properties of systems
- 64.80.Eb Stoichiometry and homogeneity
- 64.80.Gd Microstructure
- 64.90.+b** Other topics in equations of state, phase equilibria, and phase transitions
- 65. Thermal properties of condensed matter** (*see also* 05.70 Thermodynamics, 63 Lattice dynamics; *for thermodynamic properties of quantum fluids, see* 67.40.K, 67.50, 67.60; *for thermal properties of solid helium, see* 67.80.G)
- 65.20.+w Heat capacities of liquids

- 65.40.-f** Heat capacities of solids (for specific heat of superconductors, see 74.30.E; for specific heat of magnetic systems, see 75.40)
- 65.40.Em** Lattice and electron heat capacity
- 65.40.Hq** λ and Schottky anomalies
- 65.50.+m** Thermodynamic properties and entropy
- 65.70.+y** Thermal expansion and thermomechanical effects (see also 64.30 Equations of state)
- Thermal conduction in nonmetallic liquids, see 66.60; for nonmetallic solids, see 66.70
- Electronic thermal conduction, see 72.10, 72.15 and 72.20
- Thermal conductivity of superconductors, see 74.30.E
- Pyroelectric and electrocaloric effects, see 77.70
- 66. Transport properties of condensed matter (nonelectronic)**
- 66.10.-x** Diffusion and ionic conduction in liquids
- 66.10.Cb** Diffusion and thermal diffusion
- 66.10.Ed** Ionic conduction (see also 82.45 Electrochemistry)
- 66.30.-h** Diffusion in solids
- 66.30.Dn** Theory of diffusion and ionic conduction in solids
- 66.30.Fq** Self-diffusion in metals, semimetals, and alloys
- 66.30.Hs** Self-diffusion and ionic conduction in nonmetals
- 66.30.Jt** Diffusion, migration, and displacement of impurities
- 66.30.Lw** Diffusion, migration, and displacement of other defects
- 66.30.Ny** Chemical interdiffusion
- 66.60.+a** Thermal conduction in nonmetallic liquids (for thermal conduction in liquid metals, see 72.15.C)
- 66.70.+f** Nonelectronic thermal conduction and heat-pulse propagation in nonmetallic solids (for statistical mechanics of lattice vibrations, see 63.70.; for thermal conduction in solid metals, see 72.15.C and 72.15.E)
- 66.90.+r** Other topics in nonelectronic transport properties
- 67. Quantum fluids and solids; liquid and solid helium** (see also 05.30 Quantum statistical mechanics)
- 67.20.+k** Quantum effects on the structure and dynamics of nondegenerate fluids
- 67.40.-w** Boson degeneracy and superfluidity of helium-4
- 67.40.Bz** Phenomenology and two fluid models
- 67.40.Db** Quantum statistical theory; ground state, elementary excitations
- 67.40.Fd** Dynamics of relaxation phenomena
- 67.40.Hf** Hydrodynamics in specific geometries, flow in narrow channels
- 67.40.Kh** Thermodynamic properties
- 67.40.Mj** First sound
- 67.40.Pm** Transport processes, second and other sounds, and thermal counterflow
- 67.40.Rp** Films and weak link transport
- 67.40.Vs** Vortices and turbulence
- 67.40.Yv** Impurities and other defects
- 67.50.-b** Fermi fluids; liquid helium-3
- 67.50.Dg** Normal phase
- 67.50.Fi** Superfluid phase
- 67.60.-g** Mixed systems; liquid helium-3, -4 mixtures
- 67.60.Fp** He II-³He
- 67.70.+n** Films (including physical adsorption)
- 67.80.-s** Solid helium and related quantum crystals
- 67.80.Cx** Lattice dynamics and sound propagation
- 67.80.Gb** Thermal properties
- 67.80.Jd** Magnetic properties and nuclear magnetic resonance
- 67.80.Mg** Defects, impurities, and diffusion
- 67.90.+z** Other topics in quantum fluids and solids (e.g., neutron-star matter)
- 68. Surfaces and interfaces; thin films and whiskers (structure and nonelectronic properties)** (for crystal growth, see 61.50.C; for impact phenomena, see 79.20; for corrosion, oxidation, and surface treatments, see 81.60)
- 68.10.-m** Fluid surfaces and fluid-fluid interfaces
- 68.10.Cr** Surface energy (surface tension, interface tension, angle of contact, etc.)
- 68.10.Gw** Interface activity, spreading
- 68.10.Jy** Kinetics (evaporation, adsorption, condensation, catalysis, etc.) (see also 82.65 Surface processes)
- 68.15.+e** Liquid thin films
- 68.20.+t** Solid surface structures
- 68.25.+j** Mechanical and acoustical properties of solid surfaces and interfaces (for tribology, see 62.20.P; for friction, lubrication, and wear, see 81.40.P)
- 68.30.+z** Dynamics of solid surfaces and interface vibrations
- 68.40.+e** Surface energy of solids; thermodynamic properties (see also 82.65.D Thermodynamics of surfaces)
- 68.45.-v** Solid-fluid interface processes (see also 82.65.M Sorption and accommodation coefficients)
- 68.45.By** Sorption equilibrium
- 68.45.Da** Evaporation and condensation; adsorption and desorption kinetics
- 68.48.+f** Solid-solid interfaces (including bicrystals) (for grain boundaries, see 61.70.N)
- 68.55.+b** Thin film growth, structure, and epitaxy (for techniques of crystal growth and film deposition, see 81.10 and 81.15, resp.)
- 68.60.+q** Physical properties of thin films, nonelectronic
- 68.90.+g** Other topics in the structure and nonelectronic properties of surfaces and thin films

70. CONDENSED MATTER: ELECTRONIC STRUCTURE, ELECTRICAL, MAGNETIC, AND OPTICAL PROPERTIES

- 71. Electron states** (see also 63 Lattice dynamics, 73 Electronic structure and electrical properties of surfaces, interfaces, and thin films)
- 71.10.+x** General theories and computational techniques
- 71.20.+c** Electronic density of states determinations (including energy states of liquid semiconductors) (see also 65.40.E Electronic heat capacity)
- 71.25.-s** Nonlocalized single-particle electronic states
- 71.25.Cx** Techniques of band-structure calculation (general theory, applications of group theory, analytic continuation, etc.)
- 71.25.Hc** Measurement of Fermi surface parameters (including dHvA, magnetoacoustic, positron annihilation, and cyclotron resonance studies, etc.)
- 71.25.Jd** Effective mass and g-factors
- 71.25.Lf** Electron energy states in liquid metals
- 71.25.Mg** Electron energy states in amorphous and glassy solids
- 71.25.Pi** Band structure of crystalline metals
- 71.25.Rk** Band structure of crystalline elemental semiconductors
- 71.25.Tn** Band structure of crystalline semiconductor compounds and insulators

- 71.30. + h **Metal-insulator transitions**
- 71.35. + z **Excitons and related phenomena (including electron-hole drops)**
- 71.36. + c **Polaritons (including photon-phonon and photon-magnon interactions)**
- 71.38. + i **Polarons and electron-phonon interactions (see also 63.20.K Phonon-electron interactions in lattices)**
- 71.45. - d **Collective effects**
- 71.45. Gm Exchange, correlations, dielectric and magnetic functions, plasmons
- 71.45. Jp Fermi-Thomas models
- 71.45. Nt Calculations of total electronic binding energy (see also 61.50.L Crystal binding)
- 71.50. + t **Localized single-particle electronic states (excluding impurities)**
- 71.55. - i **Impurity and defect levels**
- 71.55. Dp Metals, semimetals, and alloys
- 71.55. Fr Tetrahedrally bonded nonmetals
- 71.55. Ht Other nonmetals
- 71.55. Jv Localization in disordered structures
- 71.60. + z **Positron states (see also 78.70.B Positron annihilation)**
- 71.70. - d **Level splitting and interactions (see also 73.20 Electronic surface states, 75.10 -in magnetic phenomena, 75.30.E Exchange and superexchange interactions)**
- 71.70. Ch Crystal and ligand fields
- 71.70. Ej Spin-orbit coupling, Zeeman, Stark, and strain splitting
- 71.70. Gm Exchange interactions
- 71.70. Jp Nuclear states and interactions
- 71.70. Ms Other bulk localized states and interactions (for surface states, see 73.20)
- 71.90. + q **Other topics in electron states**
- 72. Electronic transport in condensed matter (for surfaces, interfaces, and thin films, see 73)**
- 72.10. - d **Theory of electronic transport; scattering mechanisms**
- 72.10. Bg General formulation of transport theory
- 72.10. Di Scattering by phonons, magnons, and other nonlocalized excitations (see also 71.45 Collective effects)
- 72.10. Fk Scattering by point defects, dislocations, surfaces, and other imperfections (including Kondo effect)
- 72.15. - v **Electronic conduction in metals and alloys**
- 72.15. Cz Electrical and thermal conduction in amorphous and liquid metals and alloys
- 72.15. Eb Electrical and thermal conduction in crystalline metals and alloys
- 72.15. Gd Galvanomagnetic and other magnetotransport effects
- 72.15. He Thermomagnetic effects
- 72.15. Jf Thermoelectric effects
- 72.15. Lh Relaxation times and mean free paths
- 72.15. Nj Collective modes (e.g., in one-dimensional conductors)
- 72.15. Qm Scattering mechanisms and Kondo effect (see also 75.20.H Local moments in dilute alloys)
- 72.20. - i **Conductivity phenomena in semiconductors and insulators (for nonelectronic thermal conduction, see 66.70)**
- 72.20. Dp General theory, scattering mechanisms
- 72.20. Fr Low-field transport and mobility; piezoresistance
- 72.20. Ht High-field and nonlinear effects
- 72.20. Jv Charge carriers: generation, recombination, lifetime, and trapping
- 72.20. My Galvanomagnetic and other magnetotransport effects
- 72.20. Pa Thermoelectric effects
- 72.30. + q **High-frequency effects; plasma effects**
- 72.40. + w **Photoconduction and photovoltaic effects; photodielectric effects**
- 72.50. + b **Acoustoelectric effects**
- 72.55. + s **Magnetoacoustic effects**
- 72.60. + g **Mixed conductivity and conductivity transitions**
- 72.70. + m **Noise processes and phenomena**
- 72.80. - r **Conductivity of specific semiconductors and insulators**
- 72.80. Cw Elemental semiconductors
- 72.80. Ey III-V and II-VI semiconductors
- 72.80. Ga Transition-metal compounds
- 72.80. Jc Other crystalline inorganic semiconductors
- 72.80. Le Organic semiconductors
- 72.80. Ng Amorphous and glassy semiconductors
- 72.80. Ph Liquid semiconductors
- 72.90. + y **Other topics in electronic transport in condensed matter**
- 73. Electronic structure and electrical properties of surfaces, interfaces, and thin films**
- 73.20. - r **Electronic surface states (for emission and impact phenomena, see 79)**
- 73.20. Cw Ideal surfaces
- 73.20. Hb Impurity and imperfection levels
- 73.25. + i **Surface conductivity**
- 73.30. + y **Surface double layers, Schottky barriers, and work functions**
- 73.40. - c **Interfaces**
- 73.40. Cg Contact resistance, contact potential
- 73.40. Gk Tunneling: general (see also 74.50 -in superconductors)
- 73.40. Jn Metal-to-metal contacts
- 73.40. Lq Semiconductor-to-semiconductor contacts, p - n junctions, and heterojunctions
- 73.40. Mr Semiconductor-electrolyte contacts
- 73.40. Ns Metal-nonmetal contacts
- 73.40. Qv Metal-insulator-semiconductor structures (including semiconductor-to-insulator)
- 73.40. Rw Metal-insulator-metal structures
- 73.40. Sx Metal-semiconductor-metal structures
- 73.60. - n **Electronic properties of thin films**
- 73.60. Dt Metallic thin films
- 73.60. Fw Semiconductor films
- 73.60. Hy Insulating thin films
- 73.60. Ka Superconducting films
- 73.90. + f **Other topics in electrical properties of surfaces, interfaces, and thin films**
- 74. Superconductivity**
- 74.10. + v **Occurrence, critical temperature**
- 74.20. - z **Theory**
- 74.20. De Phenomenological and two-fluid theories
- 74.20. Fg BCS theory; applications
- 74.30. - e **General properties**
- 74.30. Ci Magnetization curves, Meissner effect, penetration depth
- 74.30. Ek Thermodynamic properties; thermal conductivity
- 74.30. Gn Response to electromagnetic fields, nuclear magnetic resonance, ultrasonic attenuation
- 74.40. + k **Fluctuations and critical effects**
- 74.50. + r **Proximity effects, tunneling phenomena, and Josephson effects**
- 74.55. + h **Type-I superconductivity**
- 74.60. - w **Type-II superconductivity**
- 74.60. Ec Mixed state, H_{c2} , surface sheath
- 74.60. Ge Flux pinning; fluxon-defect interactions
- 74.60. Jg Critical currents
- 74.70. - b **Superconducting materials (see also 81.40.R Electrical properties related to materials treatment)**
- 74.70. Dg Material effects on T_c , κ , critical currents
- 74.70. Gj Type-I superconductors
- 74.70. Lp Type-II superconductors
- 74.70. Nr Dirty superconductors
- 74.70. Rv Other superconducting materials
- 74.90. + n **Other topics in superconductivity**
- 75. Magnetic properties and materials (see also 81.40.R Magnetic properties related to materials treatment)**
- 75.10. - b **General theory and models of magnetic ordering (see also 05.50 Ising problems, 71.25 Nonlocalized single-particle electronic states, 71.70 Level splitting and interactions)**

- 75.10.Dg Crystal-field theory and spin Hamiltonians
- 75.10.Hk Ising and other classical spin models
- 75.10.Jm Heisenberg and other quantized localized spin models
- 75.10.Lp Band and itinerant models
- 75.20.—g Diamagnetism and paramagnetism**
- 75.20.Ck Nonmetals
- 75.20.En Metals and alloys
- 75.20.Hr Local moment in dilute alloys; Kondo effect (see also 72.15.Q Electronic conduction)
- 75.25.+z Spin arrangements in magnetically ordered materials (neutron studies, etc.)**
- 75.30.—m Magnetically ordered materials: other intrinsic properties (for critical point effects, see 75.40)**
- 75.30.Cr Saturation moments and magnetic susceptibilities
- 75.30.Ds Spin waves (see also 76.50 Spin-wave resonance)
- 75.30.Et Exchange and superexchange interactions (see also 71.70 Level splitting and interactions)
- 75.30.Gw Anisotropy
- 75.30.Hx Magnetic impurity interactions
- 75.30.Kz Magnetic phase boundaries (including magnetic transitions, metamagnetism, etc.)
- 75.40.—s Critical-point effects, specific heats, short-range order (see also 65.40 Heat capacities)**
- 75.40.Bw General theory
- 75.40.Dy Ising and other classical spin models
- 75.40.Fa Heisenberg and other quantized spin models
- 75.50.—y Studies of specific magnetic materials (see also 81.40.R Magnetic properties related to materials treatment)**
- 75.50.Bb Ferromagnetism of Fe and its alloys
- 75.50.Cc Ferromagnetism of other metals
- 75.50.Dd Ferromagnetism of nonmetals
- 75.50.Ee Antiferromagnetics
- 75.50.Gg Ferrimagnetics
- 75.50.Kj Amorphous magnetic materials
- 75.50.Mm Magnetic liquids
- 75.60.—d Domain effects, magnetization curves, and hysteresis**
- 75.60.Ch Domain walls and domain structure (for magnetic bubbles, see 75.70.K)
- 75.60.Ej Magnetization curves, hysteresis, Barkhausen and related effects
- 75.70.—i Magnetic films and plates**
- 75.70.Dp Properties in uniform state
- 75.70.Kw Domain structure (magnetic bubbles)
- 75.80.+q Magnetomechanical and magnetoelectric effects, magnetostriction**
- *Galvanomagnetic effects, see 72.15.G and 72.20.M*
- *Magneto-optical effects, see 78.20.L*
- 75.90.+w Other topics in magnetic properties and materials**
- 76. Magnetic resonances and relaxations in condensed matter; Mössbauer effect**
- 76.20.+q General theory of resonances and relaxations
- *Measurement techniques, see 07.58*
- 76.30.—v Electron paramagnetic resonance and relaxation
- 76.30.Da Ions and impurities: general
- 76.30.Fc Iron group (3d) ions and impurities (Ti—Cu)
- 76.30.He Platinum and palladium group (4d and 5d) ions and impurities (Zr—Ag and Hf—Au)
- 76.30.Kg Rare-earth ions and impurities
- 76.30.Mi Color centers and other defects
- 76.30.Pk Conduction electrons
- 76.30.Rn Free radicals
- 76.40.+b Diamagnetic and cyclotron resonances
- 76.50.+g Ferromagnetic, antiferromagnetic, and ferrimagnetic resonances; spin-wave resonance (see also 75.30.D Spin waves)
- 76.60.—k Nuclear magnetic resonance and relaxation
- 76.60.Cq Chemical and Knight shifts
- 76.60.Es Relaxation effects
- 76.60.Gv Quadrupole resonance
- 76.60.Jx Effects of internal magnetic fields
- 76.60.Lz Spin echoes
- 76.70.—r Magnetic double resonances and cross effects
- 76.70.Dx Electron—nuclear double resonance (ENDOR)
- 76.70.Ey Dynamical nuclear polarization
- 76.70.Fz Double nuclear magnetic resonance (DNMR)
- 76.70.Hb Optical double magnetic resonance (ODMR)
- 76.80.+y Mössbauer effect; other γ -ray spectroscopy
- 76.90.+d Other topics in magnetic resonances and relaxations
- 77. Dielectric properties and materials (for conductivity phenomena, see 72.20 and 72.80)**
- 77.20.+y Permittivity
- 77.30.+d Polarization and depolarization effects
- 77.40.+i Dielectric loss and relaxation
- 77.55.+f Dielectric thin films
- 77.60.+v Piezoelectricity and electrostriction (for piezo-optical effects, see 78.20.H)
- 77.70.+a Pyroelectric and electrocaloric effects
- 77.90.—e Ferroelectricity and antiferroelectricity
- 77.80.Bh Transitions and Curie point
- 77.80.Dj Domain structure and effects; hysteresis
- 77.85.+x Electrical resonances
- 77.90.+k Other topics in dielectric properties and materials
- 78. Optical properties and condensed-matter spectroscopy and other interactions of matter with particles and radiation (for phonon spectra, see 63)**
- 78.20.—e Optical properties and materials (see also 42.65 Nonlinear optics, 81.40.T Optical properties related to materials treatment; for masers and lasers, see 42.52, 42.55, and 42.60, respectively)
- 78.20.Bh General theory (for pure homogeneous materials)
- 78.20.Dj Optical constants and parameters
- 78.20.Ek Optical rotatory power
- 78.20.Fm Birefringence (including stress birefringence, flow birefringence, etc.)
- 78.20.Hp Piezo-, elasto-, and acousto-optical effects
- 78.20.Jq Electro-optical effects
- 78.20.Ls Magneto-optical effects
- 78.20.Nv Thermo-optical effects
- 78.30.—j Infrared and Raman spectra and scattering
- 78.30.Cp Infrared and Raman spectra in liquids
- 78.30.Er Infrared and Raman spectra in solid metals
- 78.30.Gt Infrared and Raman spectra in nonmetallic inorganic crystals
- 78.30.Jw Infrared and Raman spectra in organic crystals
- 78.35.+c Brillouin and Rayleigh scattering
- 78.40.—q Visible and ultraviolet spectra
- 78.40.Dw Liquids
- 78.40.Fy Tetrahedrally bonded nonmetals
- 78.40.Ha Other nonmetals
- 78.40.Kc Metals, semimetals, and alloys
- 78.45.+h Stimulated emission (see also 42.65.C—in nonlinear optics)
- 78.50.—w Impurity and defect absorption in solids
- 78.50.Ec Insulators
- 78.50.Ge Semiconductors
- 78.50.Jg Metals, semimetals, and alloys
- 78.55.—m Photoluminescence**
- 78.55.Ds Tetrahedrally bonded nonmetals
- 78.55.Fv Solid alkali halides
- 78.55.Hx Other solid inorganic materials
- 78.55.Kz Solid organic materials
- 78.60.—b Other luminescence and radiative recombination
- 78.60.Fi Electroluminescence

- 78.60.Kn Thermoluminescence
 78.60.Mq Sonoluminescence, triboluminescence
 78.60.Ps Chemiluminescence (*see also* 82.40.T Chemiluminescence and chemical laser kinetics)
 *Photoconduction and photovoltaic effects, see 72.40*
 78.65.-s Optical properties of thin films
 78.65.Ez Metals
 78.65.Jd Nonmetals
 78.70.-g Other interactions of matter with particles and radiation
 78.70.Bj Positron annihilation (*see also* 71.60 Positron states)
 78.70.Ck X-ray scattering
 78.70.Dm X-ray absorption and absorption edges

- 78.70.En X-ray emission threshold and fluorescence
 78.70.Gq Microwave and radiofrequency interactions (excluding resonances)
 78.90.+t Other topics in optical properties of condensed matter and other interactions of matter with particles and radiation

79. Electron and ion emission by liquids and solids; impact phenomena

- 79.20.-m Impact phenomena (including electron spectra and sputtering)
 79.20.Ds Laser-light impact phenomena
 79.20.Fv Electron impact: Auger emission

- 79.20.Hx Electron impact: secondary emission
 79.20.Kz Other electron impact phenomena
 79.20.Nc Atom, molecule, and ion impact
 79.20.Rf Atomic and molecular beam interactions with surfaces
 79.40.+z Thermionic emission
 79.60.-i Photoemission and photoelectron spectra
 79.60.Cn Clean metals
 79.60.Eq Semiconductors and insulators
 79.60.Gs Composite surfaces
 79.70.+q Field emission and field ionization
 79.90.+b Other topics in emission and impact phenomena in condensed matter

80. CROSS-DISCIPLINARY PHYSICS AND RELATED AREAS OF SCIENCE AND TECHNOLOGY

81. Materials science

- 81.10.-h Methods of crystal growth and purification (*for physics of crystal growth, see 61.50.C*)
 81.10.-i Methods of thin film deposition (*for epitaxy, see 68.55*)
 81.15.Cd Deposition by cathodic sputtering
 81.20.-m Other methods of preparation of materials
 81.20.Pe Glasses
 81.30.-i Phase diagrams and microstructures developed by solidification and solid-solid phase transformations (*see also* 61.70 Structure of liquids and solids and 64.70 Phase equilibria, phase transitions, and critical points of specific substances)
 81.30.Bx Phase diagrams of metals and alloys
 81.30.Dz Phase diagrams of other materials
 81.30.Fb Solidification
 81.30.Hd Constant-composition solid-solid phase transformations: polymorphic, massive, and order-disorder
 81.30.Kf Martensitic transformations
 81.40.-t Treatment of materials and its effects on microstructure and properties
 81.40.Cd Solid solution, precipitation, and dispersion hardening
 81.40.Ef Cold working, work hardening; annealing, recovery, and recrystallization; textures
 81.60.-j Corrosion, oxidation, and surface treatments
 81.60.Bn Metals and alloys

82. Physical chemistry

- 82.20.-w Chemical kinetics
 82.20.Fd Stochastic and trajectory models, other theories and models
 82.20.Kh Potential energy surfaces for chemical reactions (*see also* 31.70.F—in atomic and molecular physics; 34.20.B General potential functions, 34.50.L Chemical reactions, as studied by atomic and molecular beams)
 82.20.Mj Nonequilibrium kinetics
 82.20.Pm Measurements of rate constants, reaction cross sections, and activation energies
 82.20.Rp Energy distribution and transfer; relaxation (*see also* 31.70.H Time-dependent phenomena—in atomic and molecular physics)
 82.20.Tr Kinetic and isotope effects
 82.20.Wt Computational modeling
 82.30.-b Specific chemical reactions; reaction mechanisms
 82.30.Fi Ion-molecule, ion-ion, and charge-transfer reactions (*see also* 34.70 Charge transfer)
 82.35.+t Polymer reactions and polymerization
 82.40.-g Chemical kinetics and reactions: special regimes
 82.40.Dm Atomic and molecular beam reactions (*see also* 34.50.L Chemical reactions as studied by atomic and molecular beams)
 82.40.Tc Chemiluminescence and chemical laser kinetics (*see also* 42.55 Lasing processes, 78.60.P Chemiluminescence)
 82.45.+z Electrochemistry and electrophoresis (*see also* 66.10.E Ionic conduction in liquids; for electro-osmosis, *see* 82.65.F)

- 82.50.-m Photochemistry and radiation chemistry (*see also* 33.50 Fluorescence, phosphorescence; radiationless transitions)
 82.50.Jy Energy deposition
 82.50.La Ion-pair yields
 82.60.-s Chemical thermodynamics (*see also* 05.70 Thermodynamics)
 82.60.Fa Heat capacities and heats of phase transitions
 82.60.Lf Thermodynamics of solutions
 82.65.-i Surface processes (*see also* 68.40 Surface energy of solids; thermodynamic properties)
 82.65.Dp Thermodynamics of surfaces
 82.65.Jv Heterogeneous catalysis at surfaces and other surface reactions (*For homogeneous catalysis, see* 82.30.V)
 82.65.My Sorption and accommodation coefficients (*see also* 68.45 Solid-fluid interface processes)
 82.65.Nz Other gas-surface interactions
 82.70.-y Disperse systems
 82.70.Gg Gels and sols
 82.70.Kj Emulsions and suspensions
 82.70.Rr Aerosols and foams
 82.80.-d Chemical analysis and related physical methods of analysis
 82.80.Di Electromagnetic radiation spectrometry (including optical, x-ray, and magnetic resonance methods)
 82.80.Pv Electron spectroscopy for chemical analysis (photoelectron, Auger spectroscopy, etc.)

85. Electrical and magnetic devices

- 85.30.-z Semiconductor devices (*for photodiodes and phototransistors, see* 83.60.D)

- 85.30.Tv Field effect devices
 85.70.—w Magnetic devices
 85.70.Ge Ferrite and garnet devices

87. Biophysics, medical physics, and biomedical engineering

- 87.15.—v Molecular biophysics
 87.15.By Structure, configuration, conformation, and active sites at the molecular level

- 87.15.He Molecular dynamics, molecular probes, molecular pattern recognition
 87.15.Mi Interactions with radiations at the molecular level; luminescence
 87.20.—i Membrane biophysics
 87.20.Cn General theory of interfaces (including practical models)
 87.20.Eq Natural and artificial membranes (including immobilized enzymes)

- 87.60.—f Medical and biomedical uses of fields, radiations, and radioactivity (see also 28.80 Nuclear radiation technology, including shielding)
 87.60.Bi Sonic and ultrasonic radiation
 87.60.Dk Electric and magnetic fields (dc and pulsed)
 87.60.Gp Laser beams, microwaves, and other electromagnetic waves
 87.60.Jr Corpuscular radiation and radioisotopes

90. GEOPHYSICS, ASTRONOMY, AND ASTROPHYSICS

92. Hydrospheric and atmospheric geophysics

- 92.60.—e Meteorology (see also 43.28 Aeroacoustics and atmospheric sound)
 92.60.Mt Particles and aerosols (see also 94.20 Physics of the ionosphere)
 Atmospheric optics, see 42.68
 92.90.+x Other topics in hydrospheric and atmospheric geophysics

94. Aeronomy and space physics

- 94.10.—s Physics of the neutral atmosphere (for atmospheres of the planets, see 96.30)
 94.10.Nh Cosmic dust
 94.30.—d Physics of the magnetosphere (for magnetospheres of the planets, see 96.30)
 94.30.Kq Electric fields
 94.40.—i Cosmic rays
 94.40.Lx Composition and energy spectra
 94.40.Pa Extensive air showers
 94.40.Rc High-energy interactions

95. Fundamental astronomy and astrophysics; instrumentation, techniques, and astronomical observations

- 95.30.—k Fundamental aspects of astrophysics
 95.30.Cq Elementary particle and nuclear processes

- 95.30.Es Atomic and molecular processes and interactions
 95.30.Gv Radiation mechanisms
 95.30.Jx Radiative transfer
 95.30.Lz Hydrodynamics
 95.30.Qd Hydromagnetics and plasmas
 95.30.Sf Relativity and gravitation (see also 98.80.D Relativistic cosmology)
 Space technology, see 94.80

- 95.85.—e Astronomical observations (listed by techniques of observation)
 95.85.Sz Other observation techniques (including gravitational radiation, magnetograms, etc.)
 95.90.+v Other topics in astronomy and astrophysics

96. Solar system

- 96.50.—e Other objects in the planetary system
 96.50.Dj Interplanetary matter, magnetic and electric fields (including gegenschein and zodiacal light) (see also 94.60 Interplanetary space)
 96.60.—j Solar physics
 96.60.Kx Solar interior (including neutrino problem)
 96.60.Vg Particle radiation, solar wind (for geophysical effects, see 94.60.D, 94.60.F, and 94.60.G)

97. Stars

- 97.10.—q Stellar characteristics and properties
 97.10.Cv Stellar interiors, evolution, nucleosynthesis, ages

- 97.60.—s Late stages of stellar evolution (including black holes)
 97.60.Bw Supernovas
 97.60.Gb Pulsars
 97.60.Jd Neutron stars
 97.60.Lf Black holes
 97.60.Sm Other objects believed to be disintegrating or collapsing

98. Stellar systems; galactic and extragalactic objects and systems; the Universe

- 98.50.—v The Galaxy; extragalactic objects and systems
 98.50.Eb Formation, structure, content
 98.50.He Red shift, distances
 98.70.—f Other objects and background radiations of unknown origin or distances (for pulsars, see 97.60.G)
 98.70.Jr Quasars
 98.70.Vc Background radiations
 98.80.—k Cosmology (for observational cosmology, see 98.70.V; for origin and evolution of galaxies, see 98.50.E)
 98.80.Bp Origin and formation of the Universe (big bang, steady state, etc.)
 98.80.Dr Relativistic cosmology
 98.80.Ft Origin and formation of the elements
 99.10.+g Errata

Summary of Scheme

GENERAL

- 01. Communication, education, history, and philosophy
- 02. Mathematical methods in physics
- 03. Classical and quantum physics; mechanics and fields
- 04. Relativity and gravitation
- 05. Statistical physics and thermodynamics
- 06. Measurement science, general laboratory techniques, and instrumentation systems
- 07. Specific instrumentation and techniques of general use in physics

THE PHYSICS OF ELEMENTARY PARTICLES AND FIELDS

- 11. General theory of fields and particles
- 12. Specific theories and interaction models; particle systematics
- 13. Specific reactions and phenomenology
- 14. Properties of specific particles and resonances

NUCLEAR PHYSICS

- 21. Nuclear structure
- 23. Nuclear decay and radioactivity
- 24. Nuclear reactions and scattering: general
- 25. Nuclear reactions and scattering: specific reactions
- 27. Properties of specific nuclei listed by mass ranges
- 28. Nuclear engineering and nuclear power studies
- 29. Experimental methods and instrumentation for elementary-particle and nuclear physics

ATOMIC AND MOLECULAR PHYSICS

- 31. Electronic structure of atoms and molecules: theory
- 32. Atomic spectra and interactions with photons
- 33. Molecular spectra and interactions of molecules with photons

- 34. Atomic and molecular collision processes and interactions
- 35. Experimentally derived information on atoms and molecules; instrumentation and techniques
- 36. Studies of special atoms and molecules

CLASSICAL AREAS OF PHENOMENOLOGY (INCLUDING APPLICATIONS)

- 41. Electricity and magnetism: fields and charged particles
- 42. Optics
- 43. Acoustics
- 44. Heat flow, thermal and thermodynamic processes
- 46. Mechanics, elasticity, rheology
- 47. Fluid dynamics

FLUIDS, PLASMAS, AND ELECTRIC DISCHARGES

- 51. Kinetic and transport theory of fluids; physical properties of gases
- 52. The physics of plasmas and electric discharges

CONDENSED MATTER: STRUCTURE, MECHANICAL AND THERMAL PROPERTIES

- 61. Structure of liquids and solids; crystallography
- 62. Mechanical and acoustical properties of condensed matter
- 63. Lattice dynamics and crystal statistics
- 64. Equations of state, phase equilibria, and phase transitions
- 65. Thermal properties of condensed matter
- 66. Transport properties of condensed matter (nonelectronic)
- 67. Quantum fields and solids; liquid and solid helium
- 68. Surfaces and interfaces; thin films and whiskers (structure and nonelectronic properties)

CONDENSED MATTER: ELECTRONIC STRUCTURE, ELECTRICAL, MAGNETIC, AND OPTICAL PROPERTIES

- 71. Electron states
- 72. Electronic transport in condensed matter
- 73. Electronic structure and electrical properties of surfaces, interfaces, and thin films
- 74. Superconductivity
- 75. Magnetic properties and materials
- 76. Magnetic resonances and relaxations in condensed matter; Mössbauer effect
- 77. Dielectric properties and materials
- 78. Optical properties and condensed-matter spectroscopy and other interactions of matter with particles and radiation
- 79. Electron and ion emission by liquids and solids; impact phenomena

CROSS-DISCIPLINARY PHYSICS AND RELATED AREAS OF SCIENCE AND TECHNOLOGY

- 81. Materials science
- 82. Physical chemistry
- *84. Electromagnetic technology
- *85. Electrical and magnetic devices
- 87. Biophysics, medical physics, and biomedical engineering
- *89. Other areas of general interest to Physicists

GEOPHYSICS, ASTRONOMY, AND ASTROPHYSICS

- 91. Solid Earth physics
- 92. Hydrospheric and atmospheric geophysics
- 93. Geophysical observations, instrumentation, and techniques
- 94. Aeronomy and space physics
- 95. Fundamental astronomy and astrophysics; instrumentation, techniques, and astronomical observations
- 96. Solar system
- 97. Stars
- 98. Stellar systems; galactic and extragalactic objects and systems; the Universe

* These Sections are outside the ICSU/AB International Classification for Physics