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- 24.60.Lz [Chaos in nuclear systems](#)
- 24.70.+s [Polarization phenomena in reactions](#)
- 24.75.+i [General properties of fission](#)
- 24.85.+p [Quarks, gluons, and QCD in nuclear reactions](#)
- 25.00.00 [Nuclear reactions: specific reactions](#)
 - 25.20.-x [Photonuclear reactions](#)
 - 25.20.Dc [Photon absorption and scattering](#)
 - 25.30.-c [Lepton-induced reactions](#)
 - 25.30.Dh [Inelastic electron scattering to specific states](#)
 - 25.30.Mr [Muon-induced reactions \(including the EMC effect\)](#)
 - 25.40.-h [Nucleon-induced reactions](#)
 - 25.40.Cm [Elastic proton scattering](#)
 - 25.40.Dn [Elastic neutron scattering](#)
 - 25.40.Ep [Inelastic proton scattering](#)
 - 25.40.Fq [Inelastic neutron scattering](#)
 - 25.40.Hs [Transfer reactions](#)
 - 25.40.Kv [Charge-exchange reactions](#)
 - 25.40.Lw [Radiative capture](#)
 - 25.45.-z [\$^2\text{H}\$ -induced reactions](#)
 - 25.45.De [Elastic and inelastic scattering](#)
 - 25.45.Hi [Transfer reactions](#)
 - 25.45.Kk [Charge-exchange reactions](#)
 - 25.55.-e [\$^3\text{H}\$ -, \$^3\text{He}\$ -, and \$^4\text{He}\$ -induced reactions](#)
 - 25.55.Ci [Elastic and inelastic scattering](#)
 - 25.60.Pj [Fusion reactions](#)
 - 25.70.-z [Low and intermediate energy heavy-ion reactions](#)
 - 25.70.De [Coulomb excitation](#)
 - 25.70.Hi [Transfer reactions](#)
 - 25.70.Kk [Charge-exchange reactions](#)
 - 25.75.-q [Relativistic heavy-ion collisions](#)
 - 25.75.Nq [Quark deconfinement, quark-gluon plasma production, and phase transitions](#)
 - 25.80.-e [Meson- and hyperon-induced reactions](#)
 - 25.80.Dj [Pion elastic scattering](#)
 - 25.80.Gn [Pion charge-exchange reactions](#)
 - 25.80.Hp [Pion-induced reactions](#)
 - 25.80.Nv [Kaon-induced reactions](#)
 - 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](#)
- 26.00.00 [Nuclear astrophysics](#)
 - 26.30.-k [Nucleosynthesis in novae, supernovae, and other explosive environments](#)
 - 26.35.+c [Big Bang nucleosynthesis](#)

- 26.50.+x [Nuclear physics aspects of novae, supernovae, and other explosive environments](#)
 - 26.60.+c [Nuclear matter aspects of neutron stars](#)
 - 26.60.-c [Nuclear matter aspects of neutron stars](#)
 - 26.65.+t [Solar neutrinos](#)
- 27.00.00 Properties of specific nuclei listed by mass ranges
- 27.10.+h [A ≤ 5](#)
 - 27.20.+n [6 ≤ A ≤ 19](#)
 - 27.30.+t [20 ≤ A ≤ 38](#)
 - 27.50.+e [59 ≤ A ≤ 89](#)
 - 27.60.+j [90 ≤ A ≤ 149](#)
 - 27.80.+w [190 ≤ A < 219](#)
 - 27.90.+b [A ≥ 220](#)
- 28.00.00 Nuclear engineering and nuclear power studies
- 28.20.-v [Neutron physics](#)
 - 28.20.Cz [Neutron scattering](#)
 - 28.20.Gd [Neutron transport: diffusion and moderation](#)
 - 28.41.-i [Fission reactors](#)
 - 28.41.Ak [Theory, design, and computerized simulation](#)
 - 28.41.Bm [Fuel elements, preparation, reloading, and reprocessing](#)
 - 28.41.Kw [Radioactive wastes, waste disposal](#)
 - 28.41.My [Reactor control systems](#)
 - 28.41.Pa [Moderators](#)
 - 28.41.Te [Protection systems, safety, radiation monitoring, accidents, and dismantling](#)
 - 28.50.-k [Fission reactor types](#)
 - 28.50.Dr [Research reactors](#)
 - 28.50.Ft [Fast and breeder reactors](#)
 - 28.52.-s [Fusion reactors](#)
 - 28.52.Av [Theory, design, and computerized simulation](#)
 - 28.52.Cx [Fueling, heating and ignition](#)
 - 28.60.+s [Isotope separation and enrichment](#)
 - 28.70.+y [Nuclear explosions](#)
 - 28.90.+i [Other topics in nuclear engineering and nuclear power studies](#)
- 29.00.00 Experimental methods and instrumentation for elementary-particle and nuclear physics
- 29.17.+w [Electrostatic, collective, and linear accelerators](#)
 - 29.20.-c [Accelerators](#)
 - 29.20.D- [Cyclic accelerators and storage rings](#)
 - 29.20.Dh [Storage rings](#)
 - 29.20.Fj [Betatrons](#)
 - 29.20.Hm [Cyclotrons](#)
 - 29.20.Lq [Synchrotrons](#)
 - 29.20.db [Storage rings and colliders](#)
 - 29.25.Bx [Electron sources](#)
 - 29.25.Dz [Neutron sources](#)
 - 29.25.Ni [Ion sources: positive and negative](#)
 - 29.25.Rm [Sources of radioactive nuclei](#)
 - 29.27.-a [Beams in particle accelerators](#)
 - 29.27.Ac [Beam injection and extraction](#)

- 29.27.Bd [Beam dynamics; collective effects and instabilities](#)
 - 29.27.Fh [Beam characteristics](#)
 - 29.27.Hj [Polarized beams](#)
 - 29.30.-h [Spectrometers and spectroscopic techniques](#)
 - 29.30.Hs [Neutron spectroscopy](#)
 - 29.40.-n [Radiation detectors](#)
 - 29.40.Cs [Gas-filled counters: ionization chambers, proportional, and avalanche counters](#)
 - 29.40.Gx [Tracking and position-sensitive detectors](#)
 - 29.40.Ka [Cherenkov detectors](#)
 - 29.40.Mc [Scintillation detectors](#)
 - 29.40.Rg [Nuclear emulsions](#)
 - 29.40.Vj [Calorimeters](#)
 - 29.40.Wk [Solid-state detectors](#)
 - 29.50.+v [Computer interfaces](#)
 - 29.90.+r [Other topics in elementary-particle and nuclear physics experimental methods and instrumentation](#)
- 31.00.00 [Electronic structure of atoms and molecules: theory](#)
- 31.10.+z [Theory of electronic structure, electronic transitions, and chemical binding](#)
 - 31.15.-p [Calculations and mathematical techniques in atomic and molecular physics](#)
 - 31.15.Bs [Statistical model calculations \(including Thomas-Fermi and Thomas-Fermi-Dirac models\)](#)
 - 31.15.Ct [Semi-empirical and empirical calculations \(differential overlap, Huckel, PPP methods, etc.\)](#)
 - 31.15.E- [Density-functional theory](#)
 - 31.15.Gy [Semiclassical methods](#)
 - 31.15.Hz [Group theory](#)
 - 31.15.Md [Perturbation theory](#)
 - 31.15.Ne [Self-consistent-field methods](#)
 - 31.15.bt [Statistical model calculations \(including Thomas-Fermi and Thomas-Fermi-Dirac models\)](#)
 - 31.15.xh [Group-theoretical methods](#)
 - 31.25.-v [Electron correlation calculations for atoms and molecules](#)
 - 31.25.Jf [Electron correlation calculations for atoms and ions: excited states](#)
 - 31.25.Qm [Electron correlation calculations for polyatomic molecules](#)
 - 31.30.Gs [Hyperfine interactions and isotope effects](#)
 - 31.30.Jv [Relativistic and quantum electrodynamic effects in atoms and molecules](#)
 - 31.70.Ks [Molecular solids](#)
 - 31.90.+s [Other topics in the theory of the electronic structure of atoms and molecules](#)
- 32.00.00 [Atomic properties and interactions with photons](#)
- 32.10.-f [Properties of atoms](#)
 - 32.10.Bi [Atomic masses, mass spectra, abundances, and isotopes](#)
 - 32.10.Dk [Electric and magnetic moments, polarizabilities](#)
 - 32.10.Fn [Fine and hyperfine structure](#)
 - 32.10.Hq [Ionization potentials, electron affinities](#)

- 32.30.-r [Atomic spectra](#)
- 32.30.Bv [Radio-frequency, microwave, and infrared spectra](#)
- 32.30.Dx [Magnetic resonance spectra](#)
- 32.30.Jc [Visible and ultraviolet spectra](#)
- 32.30.Rj [X-ray spectra](#)
- 32.50.+d [Fluorescence, phosphorescence \(including quenching\)](#)
- 32.60.+i [Zeeman and Stark effects](#)
- 32.70.-n [Intensities and shapes of atomic spectral lines](#)
- 32.70.Cs [Oscillator strengths, lifetimes, transition moments](#)
- 32.70.Fw [Absolute and relative intensities](#)
- 32.70.Jz [Line shapes, widths, and shifts](#)
- 32.80.-t [Photoionization and excitation](#)
- 32.80.Bx [Level crossing and optical pumping](#)
- 32.80.Cy [Atomic scattering, cross sections, and form factors; Compton scattering](#)
- 32.80.Dz [Autoionization](#)
- 32.80.Fb [Photoionization of atoms and ions](#)
- 32.80.Gc [Photodetachment of atomic negative ions](#)
- 32.80.Hd [Auger effect](#)
- 32.80.Pj [Optical cooling of atoms; trapping](#)
- 32.80.Qk [Coherent control of atomic interactions with photons](#)
- 32.80.Rm [Multiphoton ionization and excitation to highly excited states](#)
- 32.80.Wr [Other multiphoton processes](#)
- 32.80.Ys [Weak-interaction effects in atoms](#)
- 32.90.+a [Other topics in atomic properties and interactions of atoms with photons](#)
- 33.00.00 [Molecular properties and interactions with photons](#)
 - 33.15.Bh [General molecular conformation and symmetry; stereochemistry](#)
 - 33.15.Dj [Interatomic distances and angles](#)
 - 33.15.Fm [Bond strengths, dissociation energies](#)
 - 33.15.Hp [Barrier heights \(internal rotation, inversion, rotational isomerism, conformational dynamics\)](#)
 - 33.15.Kr [Electric and magnetic moments \(and derivatives\), polarizability, and magnetic susceptibility](#)
 - 33.15.Mt [Rotation, vibration, and vibration-rotation constants](#)
 - 33.15.Pw [Fine and hyperfine structure](#)
 - 33.15.Ry [Ionization potentials, electron affinities, molecular core binding energy](#)
 - 33.15.Ta [Mass spectra](#)
 - 33.20.-t [Molecular spectra \(see also 78.47.J- Ultrafast spectroscopy \(](#)
 - 33.20.Bx [Radio-frequency and microwave spectra](#)
 - 33.20.Ea [Infrared spectra](#)
 - 33.20.Fb [Raman and Rayleigh spectra \(including optical scattering\)](#)
 - 33.20.Lg [Ultraviolet spectra](#)
 - 33.20.Ni [Vacuum ultraviolet spectra](#)
 - 33.20.Sn [Rotational analysis](#)
 - 33.20.Tp [Vibrational analysis](#)
 - 33.20.Vq [Vibration-rotation analysis](#)

- 33.20.Wr [Vibronic, rovibronic, and rotation-electron-spin interactions](#)
- 33.25.+k [Nuclear resonance and relaxation](#)
- 33.50.-j [Fluorescence and phosphorescence; radiationless transitions, quenching](#)
- 33.50.Dq [Fluorescence and phosphorescence spectra](#)
- 33.50.Hv [Radiationless transitions, quenching](#)
- 33.55.Be [Zeeman and Stark effects](#)
- 33.60.Fy [X-ray photoelectron spectra](#)
- 33.70.Ca [Oscillator and band strengths, lifetimes, transition moments, and Franck-Condon factors](#)
- 33.70.Fd [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.Be [Level crossing and optical pumping](#)
- 33.80.Eh [Autoionization, photoionization, and photodetachment](#)
- 33.80.Gj [Diffuse spectra; predissociation, photodissociation](#)
- 33.80.Rv [Multiphoton ionization and excitation to highly excited states \(e.g., Rydberg states\)](#)
- 33.80.Wz [Other multiphoton processes](#)
- 33.90.+h [Other topics in molecular properties and interactions with photons](#)
- 34.00.00 Atomic and molecular collision processes and interactions
 - 34.10.+x [General theories and models of atomic and molecular collisions and interactions \(including statistical theories, transition state, stochastic and trajectory models, etc.\)](#)
 - 34.20.-b [Interatomic and intermolecular potentials and forces, potential energy surfaces for collisions](#)
 - 34.20.Gj [Intermolecular and atom-molecule potentials and forces](#)
 - 34.30.+h [Intramolecular energy transfer; intramolecular dynamics; dynamics of van der Waals molecules](#)
 - 34.35.+a [Interactions of atoms and molecules with surfaces](#)
 - 34.50.-s [Scattering of atoms and molecules](#)
 - 34.50.Bw [Energy loss and stopping power](#)
 - 34.50.Dy [Interactions of atoms and molecules with surfaces; photon and electron emission; neutralization of ions](#)
 - 34.50.Fa [Electronic excitation and ionization of atoms \(including beam-foil excitation and ionization\)](#)
 - 34.50.Gb [Electronic excitation and ionization of molecules](#)
 - 34.50.Lf [Chemical reactions](#)
 - 34.70.+e [Charge transfer](#)
 - 34.80.-i [Electron and positron scattering](#)
 - 34.80.Bm [Elastic scattering](#)
 - 34.80.Dp [Atomic excitation and ionization](#)
 - 34.80.Gs [Molecular excitation and ionization](#)
 - 34.80.Ht [Dissociation and dissociative attachment](#)
 - 34.80.Lx [Recombination, attachment, and positronium formation](#)
 - 34.80.Nz [Spin dependence of cross sections; polarized beam experiments](#)

- 36.00.00 Exotic atoms and molecules; macromolecules; clusters
 - 36.10.–k [Exotic atoms and molecules \(containing mesons, antiprotons and other unusual particles\)](#)
 - 36.10.Dr [Positronium](#)
 - 36.10.Gv [Mesonic, hyperonic and antiprotonic atoms and molecules](#)
 - 36.20.–r [Macromolecules and polymer molecules](#)
 - 36.20.Ey [Conformation \(statistics and dynamics\)](#)
 - 36.20.Fz [Constitution \(chains and sequences\)](#)
 - 36.20.Hb [Configuration \(bonds, dimensions\)](#)
 - 36.20.Ng [Vibrational and rotational structure, infrared and Raman spectra](#)
 - 36.40.–c [Atomic and molecular clusters](#)
 - 36.40.Ei [Phase transitions in clusters](#)
 - 36.40.Gk [Plasma and collective effects in clusters](#)
 - 36.40.Mr [Spectroscopy and geometrical structure of clusters](#)
 - 36.40.Sx [Diffusion and dynamics of clusters](#)
 - 36.40.Vz [Optical properties of clusters](#)
- 37.00.00 Mechanical control of atoms, molecules, and ions
 - 37.10.De [Atom cooling methods](#)
 - 37.10.Ty [Ion trapping](#)
- 39.00.00 Instrumentation and techniques for atomic and molecular physics
 - 39.10.+j [Atomic and molecular beam sources and techniques](#)
 - 39.30.+w [Spectroscopic techniques](#)
 - 39.90.+d [Other instrumentation and techniques for atomic and molecular physics](#)
- 41.00.00 Electromagnetism; electron and ion optics
 - 41.20.–q [Applied classical electromagnetism](#)
 - 41.20.Cv [Electrostatics; Poisson and Laplace equations, boundary-value problems](#)
 - 41.20.Gz [Magnetostatics; magnetic shielding, magnetic induction, boundary-value problems](#)
 - 41.20.Jb [Electromagnetic wave propagation; radiowave propagation](#)
 - 41.50.+h [X-ray beams and x-ray optics](#)
 - 41.60.–m [Radiation by moving charges](#)
 - 41.60.Ap [Synchrotron radiation](#)
 - 41.60.Bq [Cherenkov radiation](#)
 - 41.60.Cr [Free-electron lasers](#)
 - 41.75.–i [Charged-particle beams](#)
 - 41.75.Ak [Positive-ion beams](#)
 - 41.75.Fr [Electron and positron beams](#)
 - 41.75.Ht [Relativistic electron and positron beams](#)
 - 41.75.Jv [Laser-driven acceleration](#)
 - 41.85.–p [Beam optics](#)
 - 41.85.Ct [Particle beam shaping, beam splitting](#)
 - 41.85.Gy [Chromatic and geometrical aberrations](#)
 - 41.85.Lc [Particle beam focusing and bending magnets, wiggler magnets, and quadrupoles](#)
 - 41.90.+e [Other topics in electromagnetism; electron and ion optics](#)

42.00.00 Optics

- 42.15.-i [Geometrical optics](#)
- 42.15.Dp [Wave fronts and ray tracing](#)
- 42.15.Fr [Aberrations](#)
- 42.25.-p [Wave optics](#)
- 42.25.Bs [Wave propagation, transmission and absorption](#)
- 42.25.Dd [Wave propagation in random media](#)
- 42.25.Fx [Diffraction and scattering](#)
- 42.25.Gy [Edge and boundary effects; reflection and refraction](#)
- 42.25.Hz [Interference](#)
- 42.25.Ja [Polarization](#)
- 42.25.Kb [Coherence](#)
- 42.25.Lc [Birefringence](#)
- 42.30.-d [Imaging and optical processing](#)
- 42.30.Kq [Fourier optics](#)
- 42.30.Lr [Modulation and optical transfer functions](#)
- 42.30.Ms [Speckle and moiré patterns](#)
- 42.30.Rx [Phase retrieval](#)
- 42.30.Va [Image forming and processing](#)
- 42.30.Wb [Image reconstruction; tomography](#)
- 42.40.-i [Holography](#)
- 42.40.Eq [Holographic optical elements; holographic gratings](#)
- 42.40.Ht [Hologram recording and readout methods](#)
- 42.40.Kw [Holographic interferometry; other holographic techniques](#)
- 42.40.Lx [Diffraction efficiency, resolution, and other hologram characteristics](#)
- 42.40.My [Applications](#)
- 42.40.Pa [Volume holograms](#)
- 42.50.-p [Quantum optics](#)
- 42.50.Ar [Photon statistics and coherence theory](#)
- 42.50.Ct [Quantum description of interaction of light and matter; related experiments](#)
- 42.50.Dv [Quantum state engineering and measurements](#)
- 42.50.Ex [Optical implementations of quantum information processing and transfer](#)
- 42.50.Fx [Cooperative phenomena in quantum optical systems](#)
- 42.50.Gy [Effects of atomic coherence on propagation, absorption, and amplification of light; electromagnetically induced transparency and absorption](#)
- 42.50.Hz [Strong-field excitation of optical transitions in quantum systems; multiphoton processes; dynamic Stark shift](#)
- 42.50.Lc [Quantum fluctuations, quantum noise, and quantum jumps](#)
- 42.50.Md [Optical transient phenomena: quantum beats, photon echo, free-induction decay, dephasings and revivals, optical nutation, and self-induced transparency](#)
- 42.50.Nn [Quantum optical phenomena in absorbing, amplifying, dispersive and conducting media; cooperative phenomena in quantum optical systems](#)
- 42.50.Pq [Cavity quantum electrodynamics; micromasers](#)

- 42.50.Wk [Mechanical effects of light on material media, microstructures and particles](#)
- 42.55.-f [Lasers](#)
- 42.55.Ah [General laser theory](#)
- 42.55.Ks [Chemical lasers](#)
- 42.55.Lt [Gas lasers including excimer and metal-vapor lasers](#)
- 42.55.Mv [Dye lasers](#)
- 42.55.Px [Semiconductor lasers; laser diodes](#)
- 42.55.Rz [Doped-insulator lasers and other solid state lasers](#)
- 42.55.Vc [X- and \$\gamma\$ -ray lasers](#)
- 42.55.Wd [Fiber lasers](#)
- 42.55.Ye [Raman lasers](#)
- 42.60.-v [Laser optical systems: design and operation](#)
- 42.60.By [Design of specific laser systems](#)
- 42.60.Da [Resonators, cavities, amplifiers, arrays, and rings](#)
- 42.60.Fc [Modulation, tuning, and mode locking](#)
- 42.60.Gd [Q-switching](#)
- 42.60.Jf [Beam characteristics: profile, intensity, and power; spatial pattern formation](#)
- 42.60.Lh [Efficiency, stability, gain, and other operational parameters](#)
- 42.60.Mi [Dynamical laser instabilities; noisy laser behavior](#)
- 42.60.Pk [Continuous operation](#)
- 42.60.Rn [Relaxation oscillations and long pulse operation](#)
- 42.62.-b [Laser applications](#)
- 42.62.Be [Biological and medical applications](#)
- 42.62.Cf [Industrial applications](#)
- 42.62.Eh [Metrological applications; optical frequency synthesizers for precision spectroscopy](#)
- 42.62.Fi [Laser spectroscopy](#)
- 42.65.-k [Nonlinear optics](#)
- 42.65.An [Optical susceptibility, hyperpolarizability](#)
- 42.65.Dr [Stimulated Raman scattering; CARS](#)
- 42.65.Es [Stimulated Brillouin and Rayleigh scattering](#)
- 42.65.Hw [Phase conjugation; photorefractive and Kerr effects](#)
- 42.65.Jx [Beam trapping, self-focusing and defocusing; self-phase modulation](#)
- 42.65.Ky [Frequency conversion; harmonic generation, including higher-order harmonic generation](#)
- 42.65.Lm [Parametric down conversion and production of entangled photons](#)
- 42.65.Pc [Optical bistability, multistability, and switching, including local field effects](#)
- 42.65.Re [Ultrafast processes; optical pulse generation and pulse compression](#)
- 42.65.Sf [Dynamics of nonlinear optical systems; optical instabilities, optical chaos and complexity, and optical spatio-temporal dynamics](#)
- 42.65.Tg [Optical solitons; nonlinear guided waves](#)
- 42.65.Wi [Nonlinear waveguides](#)
- 42.65.Yj [Optical parametric oscillators and amplifiers](#)
- 42.66.-p [Physiological optics](#)

- 42.66.Ct [Anatomy and optics of eye](#)
- 42.68.-w [Atmospheric and ocean optics](#)
- 42.68.Ay [Propagation, transmission, attenuation, and radiative transfer](#)
- 42.68.Bz [Atmospheric turbulence effects](#)
- 42.68.Ca [Spectral absorption by atmospheric gases](#)
- 42.68.Jg [Effects of aerosols](#)
- 42.68.Kh [Effects of air pollution](#)
- 42.68.Mj [Scattering, polarization](#)
- 42.68.Wt [Remote sensing; LIDAR and adaptive systems](#)
- 42.68.Xy [Ocean optics](#)
- 42.70.-a [Optical materials](#)
- 42.70.Ce [Glasses, quartz](#)
- 42.70.Df [Liquid crystals](#)
- 42.70.Hj [Laser materials](#)
- 42.70.Jk [Polymers and organics](#)
- 42.70.Ln [Holographic recording materials; optical storage media](#)
- 42.70.Mp [Nonlinear optical crystals](#)
- 42.70.Nq [Other nonlinear optical materials; photorefractive and semiconductor materials](#)
- 42.70.Qs [Photonic bandgap materials](#)
- 42.72.-g [Optical sources and standards](#)
- 42.72.Bj [Visible and ultraviolet sources](#)
- 42.79.-e [Optical elements, devices, and systems](#)
- 42.79.Ag [Apertures, collimators](#)
- 42.79.Bh [Lenses, prisms and mirrors](#)
- 42.79.Ci [Filters, zone plates, and polarizers](#)
- 42.79.Dj [Gratings](#)
- 42.79.Fm [Reflectors, beam splitters, and deflectors](#)
- 42.79.Gn [Optical waveguides and couplers](#)
- 42.79.Hp [Optical processors, correlators, and modulators](#)
- 42.79.Jq [Acousto-optical devices](#)
- 42.79.Kr [Display devices, liquid-crystal devices](#)
- 42.79.Ls [Scanners, image intensifiers, and image converters](#)
- 42.79.Pw [Imaging detectors and sensors](#)
- 42.79.Sz [Optical communication systems, multiplexers, and demultiplexers](#)
- 42.79.Wc [Optical coatings](#)
- 42.81.-i [Fiber optics](#)
- 42.81.Bm [Fabrication, cladding, and splicing](#)
- 42.81.Dp [Propagation, scattering, and losses; solitons](#)
- 42.81.Gs [Birefringence, polarization](#)
- 42.81.Pa [Sensors, gyros](#)
- 42.81.Qb [Fiber waveguides, couplers, and arrays](#)
- 42.81.Wg [Other fiber-optical devices](#)
- 42.82.-m [Integrated optics](#)
- 42.82.Cr [Fabrication techniques; lithography, pattern transfer](#)
- 42.82.Et [Waveguides, couplers, and arrays](#)
- 42.82.Gw [Other integrated-optical elements and systems](#)
- 43.00.00 [Acoustics](#)
- 43.10.Ce [Conferences, lectures, and announcements](#)

- 43.10.Df [Other acoustical societies and their publications, online journals, and other electronic publications](#)
- 43.10.Eg [Biographical, historical, and personal notes](#)
- 43.10.Sv [Education in acoustics, tutorial papers of interest to acoustics educators](#)
- 43.20.+g [General linear acoustics](#)
- 43.20.Bi [Mathematical theory of wave propagation](#)
- 43.20.Dk [Ray acoustics](#)
- 43.20.El [Reflection, refraction, diffraction of acoustic waves](#)
- 43.20.Fn [Scattering of acoustic waves](#)
- 43.20.Rz [Steady-state radiation from sources, impedance, radiation patterns, boundary element methods](#)
- 43.25.+y [Nonlinear acoustics](#)
- 43.25.-x [Nonlinear acoustics](#)
- 43.25.Dc [Nonlinear acoustics of solids](#)
- 43.25.Ed [Effect of nonlinearity on velocity and attenuation](#)
- 43.25.Hg [Interaction of intense sound waves with noise](#)
- 43.25.Nm [Acoustic streaming](#)
- 43.25.Vt [Intense sound sources](#)
- 43.25.Yw [Nonlinear acoustics of bubbly liquids](#)
- 43.28.-g [Aeroacoustics and atmospheric sound](#)
- 43.28.Bj [Mechanisms affecting sound propagation in air, sound speed in the air](#)
- 43.28.Mw [Shock and blast waves, sonic boom](#)
- 43.28.Py [Interaction of fluid motion and sound, Doppler effect, and sound in flow ducts](#)
- 43.30.+m [Underwater sound](#)
- 43.30.-k [Underwater sound](#)
- 43.30.Jx [Radiation from objects vibrating under water, acoustic and mechanical impedance](#)
- 43.35.Bf [Ultrasonic velocity, dispersion, scattering, diffraction, and attenuation in liquids, liquid crystals, suspensions, and emulsions](#)
- 43.35.Cg [Ultrasonic velocity, dispersion, scattering, diffraction, and attenuation in solids; elastic constants](#)
- 43.35.Pt [Surface waves in solids and liquids](#)
- 43.35.Rw [Magnetoacoustic effect; oscillations and resonance](#)
- 43.35.Sx [Acoustooptical effects, optoacoustics, acoustical visualization, acoustical microscopy, and acoustical holography](#)
- 43.35.Ud [Thermoacoustics, high temperature acoustics, photoacoustic effect](#)
- 43.35.Xd [Nuclear acoustical resonance, acoustical magnetic resonance](#)
- 43.35.Yb [Ultrasonic instrumentation and measurement techniques](#)
- 43.35.Zc [Use of ultrasonics in nondestructive testing, industrial processes, and industrial products](#)
- 43.38.-p [Transduction; acoustical devices for the generation and reproduction of sound](#)
- 43.38.Ja [Loudspeakers and horns, practical sound sources](#)
- 43.38.Kb [Microphones and their calibration](#)
- 43.38.Zp [Acoustooptic and photoacoustic transducers](#)

- 43.55.Dt [Sound absorption in enclosures: theory and measurement; use of absorption in offices, commercial and domestic spaces](#)
- 43.58.–e [Acoustical measurements and instrumentation \(see also specific sections for specialized instrumentation\)](#)
- 43.58.Kr [Spectrum and frequency analyzers and filters; acoustical and electrical oscillographs; photoacoustic spectrometers; acoustical delay lines and resonators](#)
- 43.58.Ls [Acoustical lenses and microscopes](#)
- 43.60.–c [Acoustic signal processing](#)
- 43.60.Vx [Acoustic sensing and acquisition](#)
- 43.66.Lj [Perceptual effects of sound](#)
- 44.00.00 [Heat transfer](#)
 - 44.05.+e [Analytical and numerical techniques](#)
 - 44.10.+i [Heat conduction](#)
 - 44.25.+f [Natural convection](#)
 - 44.30.+v [Heat flow in porous media](#)
 - 44.35.+c [Heat flow in multiphase systems](#)
 - 44.40.+a [Thermal radiation](#)
 - 44.90.+c [Other topics in heat transfer](#)
- 45.00.00 [Classical mechanics of discrete systems](#)
 - 45.05.+x [General theory of classical mechanics of discrete systems](#)
 - 45.20.–d [Formalisms in classical mechanics](#)
 - 45.20.D– [Newtonian mechanics](#)
 - 45.20.dc [Rotational dynamics](#)
 - 45.20.df [Momentum conservation](#)
 - 45.20.dh [Energy conservation](#)
 - 45.40.Cc [Rigid body and gyroscope motion](#)
 - 45.50.Pk [Celestial mechanics](#)
 - 45.50.Tn [Collisions](#)
- 46.00.00 [Continuum mechanics of solids](#)
 - 46.40.Ff [Resonance, damping, and dynamic stability](#)
- 47.00.00 [Fluid dynamics](#)
 - 47.10.+g [General theory](#)
 - 47.10.–g [General theory in fluid dynamics](#)
 - 47.10.A– [Mathematical formulations](#)
 - 47.10.ab [Conservation laws and constitutive relations](#)
 - 47.10.ad [Navier-Stokes equations](#)
 - 47.11.–j [Computational methods in fluid dynamics](#)
 - 47.15.–x [Laminar flows](#)
 - 47.15.G– [Low-Reynolds-number \(creeping\) flows](#)
 - 47.20.–k [Flow instabilities](#)
 - 47.20.Bp [Buoyancy-driven instabilities \(e.g., Rayleigh-Benard\)](#)
 - 47.20.Dr [Surface-tension-driven instability](#)
 - 47.20.Ft [Instability of shear flows \(e.g., Kelvin-Helmholtz\)](#)
 - 47.20.Ib [Instability of boundary layers; separation](#)
 - 47.20.Ky [Nonlinearity, bifurcation, and symmetry breaking](#)
 - 47.20.Qr [Centrifugal instabilities \(e.g., Taylor-Couette flow\)](#)
 - 47.27.–i [Turbulent flows](#)
 - 47.27.Ak [Fundamentals](#)
 - 47.27.Cn [Transition to turbulence](#)

- 47.27.De [Coherent structures](#)
- 47.27.E- [Turbulence simulation and modeling](#)
- 47.27.Gs [Isotropic turbulence; homogeneous turbulence](#)
- 47.27.Jv [High-Reynolds-number turbulence](#)
- 47.27.Qb [Turbulent diffusion](#)
- 47.27.ed [Dynamical systems approaches](#)
- 47.27.ef [Field-theoretic formulations and renormalization](#)
- 47.27.er [Spectral methods](#)
- 47.32.-y [Vortex dynamics; rotating fluids](#)
- 47.32.C- [Vortex dynamics](#)
- 47.32.Ef [Rotating and swirling flows](#)
- 47.32.cd [Vortex stability and breakdown](#)
- 47.35.+i [Hydrodynamic waves](#)
- 47.35.Bb [Gravity waves](#)
- 47.35.De [Shear waves](#)
- 47.35.Fg [Solitary waves](#)
- 47.35.Pq [Capillary waves](#)
- 47.35.Rs [Sound waves](#)
- 47.37.+q [Hydrodynamic aspects of superfluidity; quantum fluids](#)
- 47.40.-x [Compressible flows; shock waves](#)
- 47.40.Dc [General subsonic flows](#)
- 47.40.Hg [Transonic flows](#)
- 47.40.Ki [Supersonic and hypersonic flows](#)
- 47.40.Nm [Shock wave interactions and shock effects](#)
- 47.40.Rs [Detonation waves](#)
- 47.45.Ab [Kinetic theory of gases](#)
- 47.45.Gx [Slip flows and accommodation](#)
- 47.52.+j [Chaos in fluid dynamics](#)
- 47.53.+n [Fractals in fluid dynamics](#)
- 47.55.D- [Drops and bubbles](#)
- 47.55.dp [Cavitation and boiling](#)
- 47.55.dr [Interactions with surfaces](#)
- 47.55.pb [Thermal convection](#)
- 47.56.+r [Flows through porous media](#)
- 47.60.+i [Flows in ducts, channels, nozzles, and conduits](#)
- 47.63.Gd [Swimming microorganisms](#)
- 47.65.-d [Magnetohydrodynamics and electrohydrodynamics](#)
- 47.65.Md [Plasma dynamos](#)
- 47.70.Fw [Chemically reactive flows](#)
- 47.70.Pq [Flames; combustion](#)
- 47.80.-v [Instrumentation and measurement methods in fluid dynamics](#)
- 47.80.Cb [Velocity measurements](#)
- 47.80.Fg [Pressure and temperature measurements](#)
- 47.85.Dh [Hydrodynamics, hydraulics, hydrostatics](#)
- 47.85.Gj [Aerodynamics](#)
- 51.00.00 [Physics of gases](#)
 - 51.10.+y [Kinetic and transport theory of gases](#)
 - 51.20.+d [Viscosity, diffusion, and thermal conductivity](#)
 - 51.30.+i [Thermodynamic properties, equations of state](#)
 - 51.40.+p [Acoustical properties](#)
 - 51.50.+v [Electrical properties](#)

- 51.70.+f [Optical and dielectric properties](#)
- 52.00.00 [Physics of plasmas and electric discharges](#)
 - 52.20.-j [Elementary processes in plasmas](#)
 - 52.20.Dq [Particle orbits](#)
 - 52.20.Fs [Electron collisions](#)
 - 52.20.Hv [Atomic, molecular, ion, and heavy-particle collisions](#)
 - 52.25.-b [Plasma properties](#)
 - 52.25.Dg [Plasma kinetic equations](#)
 - 52.25.Fi [Transport properties](#)
 - 52.25.Gj [Fluctuation and chaos phenomena](#)
 - 52.25.Jm [Ionization of plasmas](#)
 - 52.25.Kn [Thermodynamics of plasmas](#)
 - 52.25.Mq [Dielectric properties](#)
 - 52.25.Os [Emission, absorption, and scattering of electromagnetic radiation](#)
 - 52.25.Tx [Emission, absorption, and scattering of particles](#)
 - 52.25.Vy [Impurities in plasmas](#)
 - 52.25.Xz [Magnetized plasmas](#)
 - 52.27.Cm [Multicomponent and negative-ion plasmas](#)
 - 52.27.Ep [Electron-positron plasmas](#)
 - 52.27.Gr [Strongly-coupled plasmas](#)
 - 52.27.Lw [Dusty or complex plasmas; plasma crystals](#)
 - 52.27.Ny [Relativistic plasmas](#)
 - 52.30.-q [Plasma dynamics and flow](#)
 - 52.30.Cv [Magnetohydrodynamics](#)
 - 52.35.-g [Waves, oscillations, and instabilities in plasmas and intense beams](#)
 - 52.35.Bj [Magnetohydrodynamic waves \(e.g., Alfvén waves\)](#)
 - 52.35.Dm [Sound waves](#)
 - 52.35.Fp [Electrostatic waves and oscillations \(e.g., ion-acoustic waves\)](#)
 - 52.35.Hr [Electromagnetic waves \(e.g., electron-cyclotron, Whistler, Bernstein, upper hybrid, lower hybrid\)](#)
 - 52.35.Kt [Drift waves](#)
 - 52.35.Mw [Nonlinear phenomena: waves, wave propagation, and other interactions \(including parametric effects, mode coupling, ponderomotive effects, etc.\)](#)
 - 52.35.Py [Macroinstabilities \(hydromagnetic, e.g., kink, fire-hose, mirror, ballooning, tearing, trapped-particle, flute, Rayleigh-Taylor, etc.\)](#)
 - 52.35.Qz [Microinstabilities \(ion-acoustic, two-stream, loss-cone, beam-plasma, drift, ion- or electron-cyclotron, etc.\)](#)
 - 52.35.Ra [Plasma turbulence](#)
 - 52.35.Sb [Solitons; BGK modes](#)
 - 52.35.Tc [Shock waves and discontinuities](#)
 - 52.35.We [Plasma vorticity](#)
 - 52.38.-r [Laser-plasma interactions](#)
 - 52.38.Bv [Rayleigh scattering; stimulated Brillouin and Raman scattering](#)
 - 52.38.Dx [Laser light absorption in plasmas \(collisional, parametric, etc.\)](#)

- 52.38.Hb [Self-focussing, channeling, and filamentation in plasmas](#)
- 52.38.Kd [Laser-plasma acceleration of electrons and ions](#)
- 52.38.Ph [X-ray, \$\gamma\$ -ray, and particle generation](#)
- 52.40.-w [Plasma interactions \(nonlaser\)](#)
- 52.40.Db [Electromagnetic](#)
- 52.40.Fd [Plasma interactions with antennas; plasma-filled waveguides](#)
- 52.40.Hf [Plasma-material interactions; boundary layer effects](#)
- 52.40.Kh [Plasma sheaths](#)
- 52.40.Mj [Particle beam interactions in plasmas](#)
- 52.50.-b [Plasma production and heating](#)
- 52.50.Dg [Plasma sources](#)
- 52.50.Gj [Plasma heating by particle beams](#)
- 52.50.Jm [Plasma production and heating by laser beams \(laser-foil, laser-cluster, etc.\)](#)
- 52.50.Lp [Plasma production and heating by shock waves and compression](#)
- 52.50.Qt [Plasma heating by radio-frequency fields; ICR, ICP, helicons](#)
- 52.50.Sw [Plasma heating by microwaves; ECR, LH, collisional heating](#)
- 52.55.-s [Magnetic confinement and equilibrium](#)
- 52.55.Dy [General theory and basic studies of plasma lifetime, particle and heat loss, energy balance, field structure, etc.](#)
- 52.55.Ez [Theta pinch](#)
- 52.55.Fa [Tokamaks, spherical tokamaks](#)
- 52.55.Hc [Stellarators, torsatrons, heliacs, bumpy tori, and other toroidal confinement devices](#)
- 52.55.Ip [Spheromaks](#)
- 52.55.Jd [Magnetic mirrors, gas dynamic traps](#)
- 52.55.Lf [Field-reversed configurations, rotamaks, astrons, ion rings, magnetized target fusion, and cusps](#)
- 52.55.Pi [Fusion products effects \(e.g., alpha-particles, etc.\), fast particle effects](#)
- 52.55.Rk [Power exhaust; divertors](#)
- 52.55.Tn [Ideal and resistive MHD modes; kinetic modes](#)
- 52.57.-z [Laser inertial confinement](#)
- 52.58.Lq [Z-pinches, plasma focus, and other pinch devices](#)
- 52.59.-f [Intense particle beams and radiation sources](#)
- 52.65.-y [Plasma simulation](#)
- 52.65.Ff [Fokker-Planck and Vlasov equation](#)
- 52.65.Kj [Magnetohydrodynamic and fluid equation](#)
- 52.65.Vv [Perturbative methods](#)
- 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 \(ultraviolet, visible, infrared\) measurements](#)
- 52.75.-d [Plasma devices](#)
- 52.75.Di [Ion and plasma propulsion](#)
- 52.75.Fk [Magnetohydrodynamic generators and thermionic convertors; plasma diodes](#)

- 52.77.–j [Plasma applications](#)
 - 52.80.–s [Electric discharges](#)
 - 52.80.Dy [Low-field and Townsend discharges](#)
 - 52.80.Hc [Glow; corona](#)
 - 52.80.Mg [Arcs; sparks; lightning; atmospheric electricity](#)
 - 52.80.Pi [High-frequency and RF discharges](#)
 - 52.80.Qj [Explosions; exploding wires](#)
 - 52.80.Tn [Other gas discharges](#)
 - 52.80.Vp [Discharge in vacuum](#)
 - 52.80.Wq [Discharge in liquids and solids](#)
 - 52.90.+z [Other topics in physics of plasmas and electric discharges](#)
- 61.00.00 [Structure of solids and liquids; crystallography](#)
- 61.05.–a [Techniques for structure determination](#)
 - 61.05.C– [X-ray diffraction and scattering](#)
 - 61.05.F– [Neutron diffraction and scattering](#)
 - 61.05.fg [Neutron scattering \(including small-angle scattering\)](#)
 - 61.10.–i [X-ray diffraction and scattering](#)
 - 61.10.Eq [X-ray scattering \(including small-angle scattering\)](#)
 - 61.10.Ht [X-ray absorption spectroscopy: EXAFS, NEXAFS, XANES, etc.](#)
 - 61.10.Kw [X-ray reflectometry \(surfaces, interfaces, films\)](#)
 - 61.10.Nz [X-ray diffraction](#)
 - 61.12.–q [Neutron diffraction and scattering](#)
 - 61.12.Bt [Theories of diffraction and scattering](#)
 - 61.12.Ex [Neutron scattering \(including small-angle scattering\)](#)
 - 61.12.Ld [Neutron diffraction](#)
 - 61.14.–x [Electron diffraction and scattering](#)
 - 61.14.Dc [Theories of diffraction and scattering](#)
 - 61.14.Hg [Low-energy electron diffraction \(LEED\) and reflection high-energy electron diffraction \(RHEED\)](#)
 - 61.20.–p [Structure of liquids](#)
 - 61.20.Gy [Theory and models of liquid structure](#)
 - 61.20.Ja [Computer simulation of liquid structure](#)
 - 61.20.Lc [Time-dependent properties; relaxation](#)
 - 61.20.Ne [Structure of simple liquids](#)
 - 61.25.–f [Studies of specific liquid structures](#)
 - 61.25.Hq [Macromolecular and polymer solutions; polymer melts; swelling](#)
 - 61.25.Mv [Liquid metals and alloys](#)
 - 61.30.–v [Liquid crystals](#)
 - 61.30.Cz [Molecular and microscopic models and theories of liquid crystal structure](#)
 - 61.30.Dk [Continuum models and theories of liquid crystal structure](#)
 - 61.30.Eb [Experimental determinations of smectic, nematic, cholesteric, and other structures](#)
 - 61.30.Gd [Orientational order of liquid crystals; electric and magnetic field effects on order](#)
 - 61.30.Hn [Surface phenomena: alignment, anchoring, anchoring transitions, surface-induced layering, surface-induced ordering, wetting, prewetting transitions, and wetting transitions](#)

- 61.30.Jf [Defects in liquid crystals](#)
- 61.30.Mp [Blue phases and other defect-phases](#)
- 61.30.St [Lyotropic phases](#)
- 61.30.Vx [Polymer liquid crystals](#)
- 61.41.+e [Polymers, elastomers, and plastics](#)
- 61.43.-j [Disordered solids](#)
- 61.43.Bn [Structural modeling: serial-addition models, computer simulation](#)
- 61.43.Dq [Amorphous semiconductors, metals, and alloys](#)
- 61.43.Er [Other amorphous solids](#)
- 61.43.Fs [Glasses](#)
- 61.43.Gt [Powders, porous materials](#)
- 61.43.Hv [Fractals; macroscopic aggregates \(including diffusion-limited aggregates\)](#)
- 61.44.-n [Semi-periodic solids](#)
- 61.44.Br [Quasicrystals](#)
- 61.44.Fw [Incommensurate crystals](#)
- 61.46.+w [Nanoscale materials: clusters, nanoparticles, nanotubes, and nanocrystals](#)
- 61.46.-w [Structure of nanoscale materials](#)
- 61.46.Bc [Structure of clusters \(e.g., metcars; not fragments of crystals; free or loosely aggregated or loosely attached to a substrate\)](#)
- 61.46.Df [Structure of nanocrystals and nanoparticles \("colloidal" quantum dots but not gate-isolated embedded quantum dots\)](#)
- 61.46.Np [Structure of nanotubes \(hollow nanowires\)](#)
- 61.48.+c [Fullerenes and fullerene-related materials](#)
- 61.48.-c [Structure of fullerenes and related hollow and planar molecular structures](#)
- 61.48.De [Structure of carbon nanotubes, boron nanotubes, and other related systems](#)
- 61.50.-f [Structure of bulk crystals](#)
- 61.50.Ah [Theory of crystal structure, crystal symmetry; calculations and modeling](#)
- 61.50.Ks [Crystallographic aspects of phase transformations; pressure effects](#)
- 61.50.Lt [Crystal binding; cohesive energy](#)
- 61.50.Nw [Crystal stoichiometry](#)
- 61.66.-f [Structure of specific crystalline solids](#)
- 61.66.Bi [Elemental solids](#)
- 61.66.Dk [Alloys](#)
- 61.66.Fn [Inorganic compounds](#)
- 61.66.Hq [Organic compounds](#)
- 61.72.-y [Defects and impurities in crystals; microstructure](#)
- 61.72.Bb [Theories and models of crystal defects](#)
- 61.72.Cc [Kinetics of defect formation and annealing](#)
- 61.72.Ff [Direct observation of dislocations and other defects \(etch pits, decoration, electron microscopy, x-ray topography, etc.\)](#)
- 61.72.Hh [Indirect evidence of dislocations and other defects \(resistivity, slip, creep, strains, internal friction, EPR, NMR, etc.\)](#)

- 61.72.Ji [Point defects \(vacancies, interstitials, color centers, etc.\) and defect clusters](#)
- 61.72.Lk [Linear defects: dislocations, disclinations](#)
- 61.72.Mm [Grain and twin boundaries](#)
- 61.72.Ss [Impurity concentration, distribution, and gradients](#)
- 61.72.Tt [Doping and impurity implantation in germanium and silicon](#)
- 61.72.Vv [Doping and impurity implantation in III-V and II-VI semiconductors](#)
- 61.72.Ww [Doping and impurity implantation in other materials](#)
- 61.72.Yx [Interaction between different crystal defects; gettering effect](#)
- 61.80.-x [Physical radiation effects, radiation damage](#)
- 61.80.Az [Theory and models of radiation effects](#)
- 61.80.Ba [Ultraviolet, visible, and infrared radiation effects \(including laser radiation\)](#)
- 61.80.Ed [\$\gamma\$ -ray effects](#)
- 61.80.Fe [Electron and positron radiation effects](#)
- 61.80.Hg [Neutron radiation effects](#)
- 61.80.Jh [Ion radiation effects](#)
- 61.80.Lj [Atom and molecule irradiation effects](#)
- 61.82.Bg [Metals and alloys](#)
- 61.82.Fk [Semiconductors](#)
- 61.82.Ms [Insulators](#)
- 61.82.Pv [Polymers, organic compounds](#)
- 61.85.+p [Channeling phenomena \(blocking, energy loss, etc.\)](#)
- 61.90.+d [Other topics in structure of solids and liquids; crystallography](#)
- 62.00.00 [Mechanical and acoustical properties of condensed matter](#)
 - 62.10.+s [Mechanical properties of liquids](#)
 - 62.20.-x [Mechanical properties of solids](#)
 - 62.20.Dc [Elasticity, elastic constants](#)
 - 62.20.Fe [Deformation and plasticity](#)
 - 62.20.Hg [Creep](#)
 - 62.20.Mk [Fatigue, brittleness, fracture, and cracks](#)
 - 62.20.Qp [Friction, tribology, and hardness](#)
 - 62.25.-g [Mechanical properties of nanoscale systems](#)
 - 62.25.Fg [High-frequency properties, responses to resonant or transient \(time-dependent\) fields](#)
 - 62.30.+d [Mechanical and elastic waves; vibrations](#)
 - 62.40.+i [Anelasticity, internal friction, stress relaxation, and mechanical resonances](#)
 - 62.50.+p [High-pressure and shock wave effects in solids and liquids](#)
 - 62.50.-p [High-pressure effects in solids and liquids](#)
 - 62.60.+v [Acoustical properties of liquids](#)
 - 62.65.+k [Acoustical properties of solids](#)
- 63.00.00 [Lattice dynamics](#)
 - 63.20.-e [Phonons in crystal lattices](#)
 - 63.20.Dj [Phonon states and bands, normal modes, and phonon dispersion](#)
 - 63.20.Kr [Phonon-electron and phonon-phonon interactions](#)

- 63.20.Ls [Phonon interactions with other quasiparticles](#)
- 63.20.Mt [Phonon-defect interactions](#)
- 63.20.Pw [Localized modes](#)
- 63.20.Ry [Anharmonic lattice modes](#)
- 63.20.dk [First-principles theory](#)
- 63.20.kd [Phonon-electron interactions](#)
- 63.20.kp [Phonon-defect interactions](#)
- 63.50.+x [Vibrational states in disordered systems](#)
- 63.70.+h [Statistical mechanics of lattice vibrations and displacive phase transitions](#)
- 63.90.+t [Other topics in lattice dynamics](#)
- 64.00.00 [Equations of state, phase equilibria, and phase transitions](#)
 - 64.10.+h [General theory of equations of state and phase equilibria](#)
 - 64.30.+t [Equations of state of specific substances](#)
 - 64.60.–i [General studies of phase transitions](#)
 - 64.60.Ak [Renormalization-group, fractal, and percolation studies of phase transitions](#)
 - 64.60.Cn [Order-disorder transformations](#)
 - 64.60.Fr [Equilibrium properties near critical points, critical exponents](#)
 - 64.60.Ht [Dynamic critical phenomena](#)
 - 64.60.Kw [Multicritical points](#)
 - 64.60.My [Metastable phases](#)
 - 64.60.Qb [Nucleation](#)
 - 64.60.ae [Renormalization-group theory](#)
 - 64.70.–p [Specific phase transitions](#)
 - 64.70.D– [Solid-liquid transitions](#)
 - 64.70.Dv [Solid-liquid 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](#)
 - 64.70.Md [Transitions in liquid crystals](#)
 - 64.70.P– [Glass transitions of specific systems](#)
 - 64.70.Rh [Commensurate-incommensurate transitions](#)
 - 64.75.+g [Solubility, segregation, and mixing; phase separation](#)
- 65.00.00 [Thermal properties of condensed matter](#)
 - 65.20.+w [Thermal properties of liquids: heat capacity, thermal expansion, etc.](#)
 - 65.40.–b [Thermal properties of crystalline solids](#)
 - 65.40.Ba [Heat capacity](#)
 - 65.40.De [Thermal expansion; thermomechanical effects](#)
 - 65.40.Gr [Entropy and other thermodynamical quantities](#)
 - 65.60.+a [Thermal properties of amorphous solids and glasses: heat capacity, thermal expansion, etc.](#)
 - 65.80.+n [Thermal properties of small particles, nanocrystals, and nanotubes](#)
 - 65.80.Ck [Thermal properties of graphene](#)
- 66.00.00 [Nonelectronic transport properties of condensed matter](#)
 - 66.10.Cb [Diffusion and thermal diffusion](#)
 - 66.10.Ed [Ionic conduction](#)

- 66.20.+d [Viscosity of liquids; diffusive momentum transport](#)
- 66.20.-d [Viscosity of liquids; diffusive momentum transport](#)
- 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 of impurities](#)
- 66.30.Lw [Diffusion of other defects](#)
- 66.70.+f [Nonelectronic thermal conduction and heat-pulse propagation in solids; thermal waves](#)
- 67.00.00 [Quantum fluids and solids](#)
 - 67.20.+k [Quantum effects on the structure and dynamics of nondegenerate fluids \(e.g., normal phase liquid \$^4\text{He}\$ \)](#)
 - 67.30.er [Magnetic properties, NMR](#)
 - 67.40.-w [Boson degeneracy and superfluidity of \$^4\text{He}\$](#)
 - 67.40.Bz [Phenomenology and two-fluid models](#)
 - 67.40.Fd [Dynamics of relaxation phenomena](#)
 - 67.40.Hf [Hydrodynamics in specific geometries, flow in narrow channels](#)
 - 67.40.Jg [Ions in liquid \$^4\text{He}\$](#)
 - 67.40.Kh [Thermodynamic properties](#)
 - 67.40.Mj [First sound](#)
 - 67.40.Pm [Transport processes, second and other sounds, and thermal counterflow; Kapitza resistance](#)
 - 67.40.Vs [Vortices and turbulence](#)
 - 67.55.-s [Normal phase of liquid \$^3\text{He}\$](#)
 - 67.55.Cx [Thermodynamic properties](#)
 - 67.55.Hc [Transport properties](#)
 - 67.57.-z [Superfluid phase of liquid \$^3\text{He}\$](#)
 - 67.57.Bc [Thermodynamic properties](#)
 - 67.57.De [Superflow and hydrodynamics](#)
 - 67.57.Fg [Textures and vortices](#)
 - 67.57.Hi [Transport properties](#)
 - 67.57.Jj [Collective modes](#)
 - 67.57.Lm [Spin dynamics](#)
 - 67.60.-g [Mixtures of \$^3\text{He}\$ and \$^4\text{He}\$](#)
 - 67.60.Dm [HeI- \$^3\text{He}\$](#)
 - 67.70.+n [Films \(including physical adsorption\)](#)
 - 67.80.-s [Quantum solids](#)
 - 67.80.Cx [Structure, lattice dynamics, and sound propagation](#)
 - 67.80.Mg [Defects, impurities, and diffusion](#)
 - 67.85.-d [Ultracold gases, trapped gases](#)
 - 67.90.+z [Other topics in quantum fluids and solids](#)
- 68.00.00 [Surfaces and interfaces; thin films and nanosystems \(structure and nonelectronic properties\)](#)
 - 68.03.Cd [Surface tension and related phenomena](#)
 - 68.03.Fg [Evaporation and condensation of liquids](#)
 - 68.03.Hj [Liquid surface structure: measurements and simulations](#)
 - 68.05.-n [Liquid-liquid interfaces](#)
 - 68.08.-p [Liquid-solid interfaces](#)
 - 68.15.+e [Liquid thin films](#)

- 68.18.Fg [Liquid thin film structure: measurements and simulations](#)
- 68.18.Jk [Phase transitions in liquid thin films](#)
- 68.35.-p [Solid surfaces and solid-solid interfaces: structure and energetics](#)
- 68.35.Bs [Structure of clean surfaces \(reconstruction\)](#)
- 68.35.Ct [Interface structure and roughness](#)
- 68.35.Dv [Composition, segregation; defects and impurities](#)
- 68.35.Fx [Diffusion; interface formation](#)
- 68.35.Gy [Mechanical properties; surface strains](#)
- 68.35.Iv [Acoustical properties](#)
- 68.35.Ja [Surface and interface dynamics and vibrations](#)
- 68.35.Md [Surface thermodynamics, surface energies](#)
- 68.35.Np [Adhesion](#)
- 68.35.Rh [Phase transitions and critical phenomena](#)
- 68.37.-d [Microscopy of surfaces, interfaces, and thin films](#)
- 68.37.Ef [Scanning tunneling microscopy \(including chemistry induced with STM\)](#)
- 68.37.Hk [Scanning electron microscopy \(SEM\) \(including EBIC\)](#)
- 68.37.Lp [Transmission electron microscopy \(TEM\)](#)
- 68.37.Ps [Atomic force microscopy \(AFM\)](#)
- 68.37.Vj [Field emission and field-ion microscopy](#)
- 68.37.Yz [X-ray microscopy](#)
- 68.43.-h [Chemisorption/physisorption: adsorbates on surfaces](#)
- 68.43.Fg [Adsorbate structure \(binding sites, geometry\)](#)
- 68.43.Jk [Diffusion of adsorbates, kinetics of coarsening and aggregation](#)
- 68.43.Mn [Adsorption kinetics](#)
- 68.47.De [Metallic surfaces](#)
- 68.47.Fg [Semiconductor surfaces](#)
- 68.47.Pe [Langmuir-Blodgett films on solids; polymers on surfaces; biological molecules on surfaces](#)
- 68.49.Jk [Electron scattering from surfaces](#)
- 68.49.Sf [Ion scattering from surfaces \(charge transfer, sputtering, SIMS\)](#)
- 68.49.Uv [X-ray standing waves](#)
- 68.55.A- [Nucleation and growth](#)
- 68.55.Jk [Structure and morphology; thickness; crystalline orientation and texture](#)
- 68.55.Ln [Defects and impurities: doping, implantation, distribution, concentration, etc.](#)
- 68.55.Nq [Composition and phase identification](#)
- 68.60.Bs [Mechanical and acoustical properties](#)
- 68.60.Dv [Thermal stability; thermal effects](#)
- 68.65.-k [Low-dimensional, mesoscopic, nanoscale and other related systems: structure and nonelectronic properties](#)
- 68.65.Ac [Multilayers](#)
- 68.65.Cd [Superlattices](#)
- 68.65.Pq [Graphene films](#)
- 68.70.+w [Whiskers and dendrites \(growth, structure, and nonelectronic properties\)](#)

- 68.90.+g [Other topics in structure, and nonelectronic properties of surfaces and interfaces; thin films and low-dimensional structures](#)
- 71.00.00 Electronic structure of bulk materials
 - 71.10.–w [Theories and models of many-electron systems](#)
 - 71.10.Ay [Fermi-liquid theory and other phenomenological models](#)
 - 71.10.Ca [Electron gas, Fermi gas](#)
 - 71.10.Fd [Lattice fermion models \(Hubbard model, etc.\)](#)
 - 71.15.–m [Methods of electronic structure calculations](#)
 - 71.15.Ap [Basis sets \(LCAO, plane-wave, APW, etc.\) and related methodology \(scattering methods, ASA, linearized methods, etc.\)](#)
 - 71.15.Dx [Computational methodology \(Brillouin zone sampling, iterative diagonalization, pseudopotential construction\)](#)
 - 71.15.Mb [Density functional theory, local density approximation, gradient and other corrections](#)
 - 71.15.Nc [Total energy and cohesive energy calculations](#)
 - 71.18.+y [Fermi surface: calculations and measurements; effective mass, g factor](#)
 - 71.20.–b [Electron density of states and band structure of crystalline solids](#)
 - 71.20.Be [Transition metals and alloys](#)
 - 71.20.Dg [Alkali and alkaline earth metals](#)
 - 71.20.Eh [Rare earth metals and alloys](#)
 - 71.20.Gj [Other metals and alloys](#)
 - 71.20.Mq [Elemental semiconductors](#)
 - 71.20.Nr [Semiconductor compounds](#)
 - 71.20.Ps [Other inorganic compounds](#)
 - 71.20.Rv [Polymers and organic compounds](#)
 - 71.23.–k [Electronic structure of disordered solids](#)
 - 71.23.An [Theories and models; localized states](#)
 - 71.23.Cq [Amorphous semiconductors, metallic glasses, glasses](#)
 - 71.23.Ft [Quasicrystals](#)
 - 71.27.+a [Strongly correlated electron systems; heavy fermions](#)
 - 71.28.+d [Narrow-band systems; intermediate-valence solids](#)
 - 71.30.+h [Metal-insulator transitions and other electronic transitions](#)
 - 71.35.–y [Excitons and related phenomena](#)
 - 71.35.Aa [Frenkel excitons and self-trapped excitons](#)
 - 71.35.Cc [Intrinsic properties of excitons; optical absorption spectra](#)
 - 71.35.Ee [Electron-hole drops and electron-hole plasma](#)
 - 71.35.Ji [Excitons in magnetic fields; magnetoexcitons](#)
 - 71.35.Lk [Collective effects \(Bose effects, phase space filling, and excitonic phase transitions\)](#)
 - 71.36.+c [Polaritons \(including photon-phonon and photon-magnon interactions\)](#)
 - 71.38.–k [Polarons and electron-phonon interactions](#)
 - 71.38.Ht [Self-trapped or small polarons](#)
 - 71.38.Mx [Bipolarons](#)
 - 71.45.–d [Collective effects](#)

- 71.45.Gm [Exchange, correlation, dielectric and magnetic response functions, plasmons](#)
- 71.45.Lr [Charge-density-wave systems](#)
- 71.55.-i [Impurity and defect levels](#)
- 71.55.Ak [Metals, semimetals, and alloys](#)
- 71.55.Cn [Elemental semiconductors](#)
- 71.55.Gs [II-VI semiconductors](#)
- 71.55.Ht [Other nonmetals](#)
- 71.55.Jv [Disordered structures; amorphous and glassy solids](#)
- 71.60.+z [Positron states](#)
- 71.70.-d [Level splitting and interactions](#)
- 71.70.Ch [Crystal and ligand fields](#)
- 71.70.Di [Landau levels](#)
- 71.70.Ej [Spin-orbit coupling, Zeeman and Stark splitting, Jahn-Teller effect](#)
- 71.70.Gm [Exchange interactions](#)
- 71.70.Jp [Nuclear states and interactions](#)
- 71.90.+q [Other topics in electronic structure](#)
- 72.00.00 [Electronic transport in condensed matter](#)
 - 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](#)
 - 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.Jf [Thermoelectric and thermomagnetic effects](#)
 - 72.15.Lh [Relaxation times and mean free paths](#)
 - 72.15.Qm [Scattering mechanisms and Kondo effect](#)
 - 72.15.Rn [Localization effects \(Anderson or weak localization\)](#)
 - 72.20.-i [Conductivity phenomena in semiconductors and insulators](#)
 - 72.20.Dp [General theory, scattering mechanisms](#)
 - 72.20.Ee [Mobility edges; hopping transport](#)
 - 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 and thermomagnetic effects](#)
 - 72.25.-b [Spin polarized transport](#)
 - 72.25.Ba [Spin polarized transport in metals](#)
 - 72.25.Dc [Spin polarized transport in semiconductors](#)
 - 72.25.Hg [Electrical injection of spin polarized carriers](#)
 - 72.25.Pn [Current-driven spin pumping](#)
 - 72.30.+q [High-frequency effects; plasma effects](#)
 - 72.40.+w [Photoconduction and photovoltaic 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 materials](#)
- 72.80.Cw [Elemental semiconductors](#)
- 72.80.Ey [III-V and II-VI semiconductors](#)
- 72.80.Jc [Other crystalline inorganic semiconductors](#)
- 72.80.Le [Polymers; organic compounds \(including organic semiconductors\)](#)
- 72.80.Ng [Disordered solids](#)
- 72.80.Ph [Liquid semiconductors](#)
- 72.80.Rj [Fullerenes and related materials](#)
- 72.80.Tm [Composite materials](#)
- 72.80.Vp [Electronic transport in graphene](#)
- 72.90.+y [Other topics in electronic transport in condensed matter](#)

73.00.00 [Electronic structure and electrical properties of surfaces, interfaces, thin films, and low-dimensional structures](#)

- 73.20.-r [Electron states at surfaces and interfaces](#)
- 73.20.At [Surface states, band structure, electron density of states](#)
- 73.20.Jc [Delocalization processes](#)
- 73.20.Mf [Collective excitations](#)
- 73.20.Qt [Electron solids](#)
- 73.21.-b [Electron states and collective excitations in multilayers, quantum wells, mesoscopic, and nanoscale systems](#)
- 73.21.Cd [Superlattices](#)
- 73.21.Fg [Quantum wells](#)
- 73.21.La [Quantum dots](#)
- 73.22.-f [Electronic structure of nanoscale materials and related systems](#)
- 73.23.-b [Electronic transport in mesoscopic systems](#)
- 73.25.+i [Surface conductivity and carrier phenomena](#)
- 73.30.+y [Surface double layers, Schottky barriers, and work functions](#)
- 73.40.-c [Electronic transport in interface structures](#)
- 73.40.Cg [Contact resistance, contact potential](#)
- 73.40.Gk [Tunneling](#)
- 73.40.Kp [III-V semiconductor-to-semiconductor contacts, p-n junctions, and heterojunctions](#)
- 73.40.Lq [Other 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 \(including semiconductor-to-insulator\)](#)
- 73.43.-f [Quantum Hall effects](#)
- 73.43.Cd [Theory and modeling](#)
- 73.43.Fj [Novel experimental methods; measurements](#)
- 73.43.Jn [Tunneling](#)
- 73.50.-h [Electronic transport phenomena in thin films](#)

- 73.50.Gr [Charge carriers: generation, recombination, lifetime, trapping, mean free paths](#)
- 73.50.Jt [Galvanomagnetic and other magnetotransport effects \(including thermomagnetic effects\)](#)
- 73.50.Lw [Thermoelectric effects](#)
- 73.50.Mx [High-frequency effects; plasma effects](#)
- 73.50.Pz [Photoconduction and photovoltaic effects](#)
- 73.61.-r [Electrical properties of specific thin films](#)
- 73.61.At [Metal and metallic alloys](#)
- 73.61.Le [Other inorganic semiconductors](#)
- 73.63.-b [Electronic transport in nanoscale materials and structures](#)
- 73.63.Fg [Nanotubes](#)
- 73.63.Hs [Quantum wells](#)
- 73.63.Rt [Nanoscale contacts](#)
- 73.90.+f [Other topics in electronic structure and electrical properties of surfaces, interfaces, thin films, and low-dimensional structures](#)
- 74.00.00 Superconductivity
 - 74.10.+v [Occurrence, potential candidates](#)
 - 74.20.-z [Theories and models of superconducting state](#)
 - 74.20.De [Phenomenological theories \(two-fluid, Ginzburg-Landau, etc.\)](#)
 - 74.20.Fg [BCS theory and its development](#)
 - 74.20.Mn [Nonconventional mechanisms](#)
 - 74.20.Rp [Pairing symmetries \(other than s-wave\)](#)
 - 74.25.-q [Properties of superconductors](#)
 - 74.25.Bt [Thermodynamic properties](#)
 - 74.25.Dw [Superconductivity phase diagrams](#)
 - 74.25.Fy [Transport properties \(electric and thermal conductivity, thermoelectric effects, etc.\)](#)
 - 74.25.Gz [Optical properties](#)
 - 74.25.Ha [Magnetic properties including vortex structures and related phenomena](#)
 - 74.25.Jb [Electronic structure \(photoemission, etc.\)](#)
 - 74.25.Kc [Phonons](#)
 - 74.25.Ld [Mechanical and acoustical properties, elasticity, and ultrasonic attenuation](#)
 - 74.25.Nf [Response to electromagnetic fields \(nuclear magnetic resonance, surface impedance, etc.\)](#)
 - 74.25.Op [Mixed states, critical fields, and surface sheaths](#)
 - 74.25.Qt [Vortex lattices, flux pinning, flux creep](#)
 - 74.25.Sv [Critical currents](#)
 - 74.25.Uv [Vortex phases \(includes vortex lattices, vortex liquids, and vortex glasses\)](#)
 - 74.40.+k [Fluctuations \(noise, chaos, nonequilibrium superconductivity, localization, etc.\)](#)
 - 74.45.+c [Proximity effects; Andreev reflection; SN and SNS junctions](#)
 - 74.50.+r [Tunneling phenomena; Josephson effects](#)
 - 74.62.-c [Transition temperature variations, phase diagrams](#)

- 74.62.Bf [Effects of material synthesis, crystal structure, and chemical composition](#)
- 74.62.Dh [Effects of crystal defects, doping and substitution](#)
- 74.62.Fj [Effects of pressure](#)
- 74.70.-b [Superconducting materials other than cuprates](#)
- 74.70.Ad [Metals; alloys and binary compounds \(including A15, MgB₂, etc.\)](#)
- 74.70.Dd [Ternary, quaternary, and multinary compounds \(including Chevrel phases, borocarbides, etc.\)](#)
- 74.70.Kn [Organic superconductors](#)
- 74.70.Tx [Heavy-fermion superconductors](#)
- 74.72.-h [Cuprate superconductors](#)
- 74.72.Bk [Y-based cuprates](#)
- 74.72.Dn [La-based cuprates](#)
- 74.72.Jt [Other cuprates, including Tl and Hg-based cuprates](#)
- 74.78.-w [Superconducting films and low-dimensional structures](#)
- 74.78.Bz [High- \$T_c\$ films](#)
- 74.81.Bd [Granular, melt-textured, amorphous, and composite superconductors](#)
- 74.90.+n [Other topics in superconductivity](#)
- 75.00.00 [Magnetic properties and materials](#)
 - 75.10.-b [General theory and models of magnetic ordering](#)
 - 75.10.Dg [Crystal-field theory and spin Hamiltonians](#)
 - 75.10.Hk [Classical spin models](#)
 - 75.10.Jm [Quantized spin models, including quantum spin frustration](#)
 - 75.10.Lp [Band and itinerant models](#)
 - 75.10.Nr [Spin-glass and other random models](#)
 - 75.20.-g [Diamagnetism, paramagnetism, and superparamagnetism](#)
 - 75.20.Ck [Nonmetals](#)
 - 75.25.+z [Spin arrangements in magnetically ordered materials](#)
 - 75.30.-m [Intrinsic properties of magnetically ordered materials](#)
 - 75.30.Cr [Saturation moments and magnetic susceptibilities](#)
 - 75.30.Ds [Spin waves](#)
 - 75.30.Et [Exchange and superexchange interactions](#)
 - 75.30.Fv [Spin-density waves](#)
 - 75.30.Gw [Magnetic anisotropy](#)
 - 75.30.Hx [Magnetic impurity interactions](#)
 - 75.30.Kz [Magnetic phase boundaries](#)
 - 75.30.Mb [Valence fluctuation, Kondo lattice, and heavy-fermion phenomena](#)
 - 75.30.Sg [Magnetocaloric effect, magnetic cooling](#)
 - 75.40.-s [Critical-point effects, specific heats, short-range order](#)
 - 75.40.Cx [Static properties \(order parameter, static susceptibility, heat capacities, critical exponents, etc.\)](#)
 - 75.40.Gb [Dynamic properties \(dynamic susceptibility, spin waves, spin diffusion, dynamic scaling, etc.\)](#)
 - 75.45.+j [Macroscopic quantum phenomena in magnetic systems](#)
 - 75.47.-m [Magnetotransport phenomena; materials for magnetotransport](#)
 - 75.47.Lx [Magnetic oxides](#)

- 75.47.Np [Metals and alloys](#)
- 75.50.-y [Studies of specific magnetic materials](#)
- 75.50.Bb [Fe and its alloys](#)
- 75.50.Cc [Other ferromagnetic metals and alloys](#)
- 75.50.Dd [Nonmetallic ferromagnetic materials](#)
- 75.50.Ee [Antiferromagnetics](#)
- 75.50.Gg [Ferrimagnetics](#)
- 75.50.Kj [Amorphous and quasicrystalline magnetic materials](#)
- 75.50.Lk [Spin glasses and other random magnets](#)
- 75.50.Mm [Magnetic liquids](#)
- 75.50.Pp [Magnetic semiconductors](#)
- 75.50.Ss [Magnetic recording materials](#)
- 75.50.Tt [Fine-particle systems; nanocrystalline materials](#)
- 75.50.Ww [Permanent magnets](#)
- 75.60.-d [Domain effects, magnetization curves, and hysteresis](#)
- 75.60.Ch [Domain walls and domain structure](#)
- 75.60.Ej [Magnetization curves, hysteresis, Barkhausen and related effects](#)
- 75.60.Jk [Magnetization reversal mechanisms](#)
- 75.70.-i [Magnetic properties of thin films, surfaces, and interfaces](#)
- 75.70.Ak [Magnetic properties of monolayers and thin films](#)
- 75.70.Cn [Magnetic properties of interfaces \(multilayers, superlattices, heterostructures\)](#)
- 75.70.Kw [Domain structure](#)
- 75.70.Rf [Surface magnetism](#)
- 75.75.-c [Magnetic properties of nanostructures](#)
- 75.76.+j [Spin transport effects](#)
- 75.78.-n [Magnetization dynamics](#)
- 75.80.+q [Magnetomechanical effects, magnetostriction](#)
- 75.85.+t [Magnetolectric effects, multiferroics](#)
- 75.90.+w [Other topics in magnetic properties and materials](#)
- 76.00.00 [Magnetic resonances and relaxations in condensed matter, mössbauer effect](#)
 - 76.20.+q [General theory of resonances and relaxations](#)
 - 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.Kg [Rare-earth ions and impurities](#)
 - 76.30.Lh [Other 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](#)
 - 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 \(ENDOR\), electron double resonance \(ELDOR\)](#)
 - 76.70.Fz [Double nuclear magnetic resonance \(DNMR\), dynamical nuclear polarization](#)
 - 76.75.+i [Muon spin rotation and relaxation](#)
 - 76.80.+y [Mössbauer effect; other \$\gamma\$ -ray spectroscopy](#)
- 77.00.00 [Dielectrics, piezoelectrics, and ferroelectrics and their properties](#)
- 77.22.–d [Dielectric properties of solids and liquids](#)
 - 77.22.Ch [Permittivity](#)
 - 77.22.Ej [Polarization and depolarization](#)
 - 77.22.Gm [Dielectric loss and relaxation](#)
 - 77.22.Jp [Dielectric breakdown and space-charge effects](#)
 - 77.55.+f [Dielectric thin films](#)
 - 77.55.–g [Dielectric thin films](#)
 - 77.65.–j [Piezoelectricity and electromechanical effects](#)
 - 77.65.Dq [Acoustoelectric effects and surface acoustic waves](#)
 - 77.65.Fs [Electromechanical resonance; quartz resonators](#)
 - 77.70.+a [Pyroelectric and electrocaloric effects](#)
 - 77.80.–e [Ferroelectricity and antiferroelectricity](#)
 - 77.80.Bh [Phase transitions and Curie point](#)
 - 77.80.Dj [Domain structure; hysteresis](#)
 - 77.84.–s [Dielectric, piezoelectric, ferroelectric, and antiferroelectric materials](#)
 - 77.84.Bw [Elements, oxides, nitrides, borides, carbides, chalcogenides, etc.](#)
 - 77.84.Dy [Niobates, titanates, tantalates, PZT ceramics, etc.](#)
 - 77.84.Fa [KDP- and TGS-type crystals](#)
 - 77.84.Nh [Liquids, emulsions, and suspensions; liquid crystals](#)
 - 77.90.+k [Other topics in dielectrics, piezoelectrics, and ferroelectrics and their properties](#)
- 78.00.00 [Optical properties, condensed-matter spectroscopy and other interactions of radiation and particles with condensed matter](#)
- 78.20.–e [Optical properties of bulk materials and thin films](#)
 - 78.20.Bh [Theory, models, and numerical simulation](#)
 - 78.20.Ci [Optical constants \(including refractive index, complex dielectric constant, absorption, reflection and transmission coefficients, emissivity\)](#)
 - 78.20.Ek [Optical activity](#)
 - 78.20.Fm [Birefringence](#)
 - 78.20.Hp [Piezo-, elasto-, and acoustooptical effects; photoacoustic effects](#)
 - 78.20.Jq [Electro-optical effects](#)
 - 78.20.Ls [Magneto-optical effects](#)
 - 78.20.Nv [Thermooptical and photothermal effects](#)
 - 78.30.–j [Infrared and Raman spectra](#)
 - 78.30.Cp [Liquids](#)
 - 78.30.Er [Solid metals and alloys](#)
 - 78.30.Fs [III-V and II-VI semiconductors](#)
 - 78.30.Hv [Other nonmetallic inorganics](#)
 - 78.30.Jw [Organic compounds, polymers](#)

- 78.30.Ly [Disordered solids](#)
- 78.30.Na [Fullerenes and related materials](#)
- 78.35.+c [Brillouin and Rayleigh scattering; other light scattering](#)
- 78.40.-q [Absorption and reflection spectra: visible and ultraviolet](#)
- 78.40.Dw [Liquids](#)
- 78.40.Me [Organic compounds and polymers](#)
- 78.45.+h [Stimulated emission](#)
- 78.47.+p [Time-resolved optical spectroscopies and other ultrafast optical measurements in condensed matter](#)
- 78.55.-m [Photoluminescence, properties and materials](#)
- 78.55.Ap [Elemental semiconductors](#)
- 78.55.Bq [Liquids](#)
- 78.55.Cr [III-V semiconductors](#)
- 78.55.Et [II-VI semiconductors](#)
- 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.Hk [Cathodoluminescence, ionoluminescence](#)
- 78.60.Mq [Sonoluminescence, triboluminescence](#)
- 78.60.Ps [Chemiluminescence](#)
- 78.66.-w [Optical properties of specific thin films](#)
- 78.66.Bz [Metals and metallic alloys](#)
- 78.66.Jg [Amorphous semiconductors; glasses](#)
- 78.66.Li [Other semiconductors](#)
- 78.67.-n [Optical properties of low-dimensional, mesoscopic, and nanoscale materials and structures](#)
- 78.67.De [Quantum wells](#)
- 78.67.Pt [Multilayers; superlattices; photonic structures; metamaterials](#)
- 78.68.+m [Optical properties of surfaces](#)
- 78.70.-g [Interactions of particles and radiation with matter](#)
- 78.70.Bj [Positron annihilation](#)
- 78.70.Ck [X-ray scattering](#)
- 78.70.Dm [X-ray absorption spectra](#)
- 78.70.En [X-ray emission spectra and fluorescence](#)
- 78.70.Gq [Microwave and radio-frequency interactions](#)
- 78.70.Nx [Neutron inelastic scattering](#)
- 78.90.+t [Other topics in optical properties, condensed matter spectroscopy and other interactions of particles and radiation with condensed matter](#)

79.00.00 [Electron and ion emission by liquids and solids; impact phenomena](#)

- 79.20.Ds [Laser-beam impact phenomena](#)
- 79.20.Eb [Laser ablation](#)
- 79.20.Fv [Electron impact: Auger emission](#)
- 79.20.Hx [Electron impact: secondary emission](#)
- 79.20.La [Photon- and electron-stimulated desorption](#)
- 79.20.Rf [Atomic, molecular, and ion beam impact and interactions with surfaces](#)

- 79.40.+z [Thermionic emission](#)
 - 79.60.-i [Photoemission and photoelectron spectra](#)
 - 79.60.Bm [Clean metal, semiconductor, and insulator surfaces](#)
 - 79.60.Cn [Liquids and liquid surfaces](#)
 - 79.60.Jv [Interfaces; heterostructures; nanostructures](#)
 - 79.70.+q [Field emission, ionization, evaporation, and desorption](#)
 - 79.75.+g [Exoelectron emission](#)
 - 79.90.+b [Other topics in electron and ion emission by liquids and solids and impact phenomena](#)
- 81.00.00 [Materials science](#)
- 81.05.Hd [Other semiconductors](#)
 - 81.05.ue [Graphene](#)
 - 81.07.Wx [Nanopowders](#)
 - 81.10.-h [Methods of crystal growth; physics and chemistry of crystal growth, crystal morphology, and orientation](#)
 - 81.10.Aj [Theory and models of crystal growth; physics and chemistry of crystal growth, crystal morphology, and orientation](#)
 - 81.10.Bk [Growth from vapor](#)
 - 81.10.Dn [Growth from solutions](#)
 - 81.10.Fq [Growth from melts; zone melting and refining](#)
 - 81.15.-z [Methods of deposition of films and coatings; film growth and epitaxy](#)
 - 81.15.Cd [Deposition by sputtering](#)
 - 81.15.Gh [Chemical vapor deposition](#)
 - 81.15.Hi [Molecular, atomic, ion, and chemical beam epitaxy](#)
 - 81.20.-n [Methods of materials synthesis and materials processing](#)
 - 81.30.Bx [Phase diagrams of metals, alloys, and oxides](#)
 - 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.Gh [Other heat and thermomechanical treatments](#)
 - 81.40.Jj [Elasticity and anelasticity, stress-strain relations](#)
 - 81.40.Lm [Deformation, plasticity, and creep](#)
 - 81.40.Np [Fatigue, corrosion fatigue, embrittlement, cracking, fracture, and failure](#)
 - 81.40.Pq [Friction, lubrication, and wear](#)
 - 81.65.Cf [Surface cleaning, etching, patterning](#)
 - 81.65.Mq [Oxidation](#)
 - 81.70.-q [Methods of materials testing and analysis](#)
 - 81.70.Bt [Mechanical testing, impact tests, static and dynamic loads](#)
 - 81.70.Cv [Nondestructive testing: ultrasonic testing, photoacoustic testing](#)
 - 81.70.Ex [Nondestructive testing: electromagnetic testing, eddy-current testing](#)
 - 81.70.Ha [Testing in microgravity environments](#)
- 82.00.00 [Physical chemistry and chemical physics](#)
- 82.20.-w [Chemical kinetics and dynamics](#)
 - 82.20.Fd [Collision theories; trajectory models](#)

- 82.20.Hf [Product distribution](#)
- 82.20.Ln [Semiclassical theory of reactions and/or energy transfer](#)
- 82.20.Nk [Classical theories of reactions and/or energy transfer](#)
- 82.20.Pm [Rate constants, reaction cross sections, and activation energies](#)
- 82.30.-b [Specific chemical reactions; reaction mechanisms](#)
- 82.30.Cf [Atom and radical reactions; chain reactions; molecule-molecule reactions](#)
- 82.30.Fi [Ion-molecule, ion-ion, and charge-transfer reactions](#)
- 82.30.Gg [Positronium chemistry](#)
- 82.30.Lp [Decomposition reactions \(pyrolysis, dissociation, and fragmentation\)](#)
- 82.33.Pt [Solid state chemistry](#)
- 82.33.Vx [Reactions in flames, combustion, and explosions](#)
- 82.33.Xj [Plasma reactions \(including flowing afterglow and electric discharges\)](#)
- 82.35.-x [Polymers: properties; reactions; polymerization](#)
- 82.35.Rs [Polyelectrolytes](#)
- 82.39.-k [Chemical kinetics in biological systems](#)
- 82.39.Wj [Ion exchange, dialysis, osmosis, electro-osmosis, membrane processes](#)
- 82.40.-g [Chemical kinetics and reactions: special regimes and techniques](#)
- 82.40.Fp [Shock wave initiated reactions, high-pressure chemistry](#)
- 82.45.Fk [Electrodes](#)
- 82.45.Gj [Electrolytes](#)
- 82.45.Vp [Semiconductor materials in electrochemistry](#)
- 82.50.-m [Photochemistry](#)
- 82.50.Hp [Processes caused by visible and UV light](#)
- 82.60.Cx [Enthalpies of combustion, reaction, and formation](#)
- 82.60.Hc [Chemical equilibria and equilibrium constants](#)
- 82.60.Lf [Thermodynamics of solutions](#)
- 82.65.+r [Surface and interface chemistry; heterogeneous catalysis at surfaces](#)
- 82.70.Dd [Colloids](#)
- 82.70.Gg [Gels and sols](#)
- 82.70.Kj [Emulsions and suspensions](#)
- 82.70.Rr [Aerosols and foams](#)
- 82.70.Uv [Surfactants, micellar solutions, vesicles, lamellae, amphiphilic systems,](#)
- 82.80.-d [Chemical analysis and related physical methods of analysis](#)
- 82.80.Ej [X-ray, Mössbauer, and other \$\gamma\$ -ray spectroscopic analysis methods](#)
- 82.80.Gk [Analytical methods involving vibrational spectroscopy](#)
- 82.80.Pv [Electron spectroscopy \(X-ray photoelectron \(XPS\), Auger electron spectroscopy \(AES\), etc.\)](#)
- 82.90.+j [Other topics in physical chemistry and chemical physics](#)

83.00.00 [Rheology](#)

- 83.80.Nb [Geological materials: Earth, magma, ice, rocks, etc.](#)

84.00.00 [Electronics; radiowave and microwave technology; direct energy conversion and storage](#)

- 84.30.Jc [Power electronics; power supply circuits](#)
- 84.30.Le [Amplifiers](#)
- 84.30.Ng [Oscillators, pulse generators, and function generators](#)
- 84.30.Qi [Modulators and demodulators; discriminators, comparators, mixers, limiters, and compressors](#)
- 84.30.Sk [Pulse and digital circuits](#)
- 84.30.Vn [Filters](#)
- 84.32.Ff [Conductors, resistors \(including thermistors, varistors, and photoresistors\)](#)
- 84.32.Hh [Inductors and coils; wiring](#)
- 84.32.Tt [Capacitors](#)
- 84.35.+i [Neural networks](#)
- 84.37.+q [Measurements in electric variables \(including voltage, current, resistance, capacitance, inductance, impedance, and admittance, etc.\)](#)
- 84.40.-x [Radiowave and microwave](#)
- 84.40.Az [Waveguides, transmission lines, striplines](#)
- 84.40.Ba [Antennas: theory, components and accessories](#)
- 84.40.Fe [Microwave tubes \(e.g., klystrons, magnetrons, traveling-wave, backward-wave tubes, etc.\)](#)
- 84.40.Ik [Masers; gyrotrons \(cyclotron-resonance masers\)](#)
- 84.40.Lj [Microwave integrated electronics](#)
- 84.40.Ua [Telecommunications: signal transmission and processing; communication satellites](#)
- 84.40.Xb [Telemetry: remote control, remote sensing; radar](#)
- 84.47.+w [Vacuum tubes](#)
- 84.60.-h [Direct energy conversion and storage](#)
- 84.60.Jt [Photoelectric conversion: solar cells and arrays](#)
- 84.70.+p [High-current and high-voltage technology: power systems; power transmission lines and cables](#)
- 84.71.Ba [Superconducting magnets; magnetic levitation devices](#)
- 84.71.Mn [Superconducting wires, fibers, and tapes](#)

85.00.00 [Electronic and magnetic devices; microelectronics](#)

- 85.30.-z [Semiconductor devices](#)
- 85.30.De [Semiconductor-device characterization, design, and modeling](#)
- 85.30.Kk [Junction diodes](#)
- 85.30.Mn [Junction breakdown and tunneling devices \(including resonance tunneling devices\)](#)
- 85.30.Tv [Field effect devices](#)
- 85.40.-e [Microelectronics: LSI, VLSI, ULSI; integrated circuit fabrication technology](#)
- 85.40.Bh [Computer-aided design of microcircuits; layout and modeling](#)
- 85.40.Hp [Lithography, masks and pattern transfer](#)
- 85.40.Qx [Microcircuit quality, noise, performance, and failure analysis](#)
- 85.60.-q [Optoelectronic devices](#)

- 85.60.Dw [Photodiodes; phototransistors; photoresistors](#)
- 85.60.Gz [Photodetectors](#)
- 85.60.Ha [Photomultipliers; phototubes and photocathodes](#)
- 85.60.Jb [Light-emitting devices](#)
- 85.60.Pg [Display systems](#)
- 85.65.+h [Molecular electronic devices](#)
- 85.70.-w [Magnetic devices](#)
- 85.70.Li [Other magnetic recording and storage devices \(including tapes, disks, and drums\)](#)
- 85.70.Sq [Magneto-optical devices](#)
- 87.00.00 [Biological and medical physics](#)
 - 87.10.+e [General theory and mathematical aspects](#)
 - 87.10.-e [General theory and mathematical aspects](#)
 - 87.10.Ed [Ordinary differential equations \(ODE\), partial differential equations \(PDE\), integrodifferential models](#)
 - 87.14.-g [Biomolecules: types](#)
 - 87.14.Cc [Lipids](#)
 - 87.14.Ee [Proteins](#)
 - 87.14.G- [Nucleic acids](#)
 - 87.14.Gg [DNA, RNA](#)
 - 87.15.-v [Biomolecules: structure and physical properties](#)
 - 87.15.Aa [Theory and modeling; computer simulation](#)
 - 87.15.By [Structure and bonding](#)
 - 87.15.Cc [Folding: thermodynamics, statistical mechanics, models, and pathways](#)
 - 87.15.He [Dynamics and conformational changes](#)
 - 87.15.Kg [Molecular interactions; membrane-protein interactions](#)
 - 87.15.La [Mechanical properties](#)
 - 87.15.Mi [Spectra, photodissociation, and photoionization; luminescence](#)
 - 87.15.Nn [Properties of solutions; aggregation and crystallization of macromolecules](#)
 - 87.15.Rn [Reactions and kinetics; polymerization](#)
 - 87.15.Tt [Electrophoresis](#)
 - 87.15.ht [Ultrafast dynamics; charge transfer](#)
 - 87.16.-b [Subcellular structure and processes](#)
 - 87.16.Dg [Membranes, bilayers, and vesicles](#)
 - 87.16.Sr [Chromosomes, histones](#)
 - 87.16.Tb [Mitochondria and other organelles](#)
 - 87.16.Uv [Active transport processes](#)
 - 87.17.-d [Cell processes](#)
 - 87.17.Ee [Growth and division](#)
 - 87.17.Jj [Cell locomotion, chemotaxis](#)
 - 87.18.-h [Biological complexity](#)
 - 87.18.Ed [Cell aggregation](#)
 - 87.18.Hf [Spatiotemporal pattern formation in cellular populations](#)
 - 87.18.Sn [Neural networks and synaptic communication](#)
 - 87.19.-j [Properties of higher organisms](#)
 - 87.19.Dd [Information processing in vision and hearing](#)
 - 87.19.Ff [Muscles](#)
 - 87.19.La [Neuroscience](#)

- 87.19.Nn [Electrophysiology](#)
- 87.19.Rr [Mechanical properties of tissues and organs](#)
- 87.19.Xx [Diseases](#)
- 87.19.xj [Cancer](#)
- 87.23.-n [Ecology and evolution](#)
- 87.23.Kg [Dynamics of evolution](#)
- 87.50.-a [Effects of electromagnetic and acoustic fields on biological systems](#)
- 87.50.Jk [Radio frequency and microwave radiation \(power lines\)](#)
- 87.50.Mn [Magnetic fields](#)
- 87.52.-g [Radiation monitoring, control, and safety](#)
- 87.53.-j [Effects of ionizing radiation on biological systems](#)
- 87.53.Qc [Proton, neutron, and heavier particle dosimetry: measurements](#)
- 87.53.Tf [Treatment planning, optimization, tissue response factors, and dose-volume analysis](#)
- 87.63.Lk [Visible radiation: diaphanography, transillumination, laser imaging](#)
- 87.64.-t [Spectroscopic and microscopic techniques in biophysics and medical physics](#)
- 87.64.Cc [Scattering of visible, uv, and infrared radiation](#)
- 87.64.Ee [Electron microscopy](#)
- 87.64.Gb [X-ray spectroscopy](#)
- 87.64.Je [Infrared and Raman spectroscopy](#)
- 87.64.Pj [Mossbauer spectroscopy](#)
- 87.66.Jj [Ionization dosimetry](#)
- 87.68.+z [Biomaterials and biological interfaces](#)
- 87.80.-y [Biophysical techniques \(research methods\)](#)
- 87.80.Rb [Tissue and cellular engineering and biotechnology](#)
- 89.00.00 Other areas of applied and interdisciplinary physics
 - 89.20.Bb [Industrial and technological research and development](#)
 - 89.20.Dd [Military technology and weapons systems; arms control](#)
 - 89.20.Kk [Engineering](#)
 - 89.30.Cc [Solar power](#)
 - 89.30.Gg [Nuclear fission power](#)
 - 89.30.Jj [Nuclear fusion power](#)
 - 89.60.-k [Environmental studies](#)
 - 89.60.Gg [Impact of natural and man-made disasters](#)
 - 89.65.Gh [Economics; econophysics, financial markets, business and management](#)
 - 89.70.+c [Information theory and communication theory](#)
 - 89.90.+n [Other topics in areas of applied and interdisciplinary physics](#)
- 91.00.00 Solid earth physics
 - 91.10.Kg [Crustal movements and deformation](#)
 - 91.10.Nj [Rotational variations; polar wobble](#)
 - 91.10.Op [Gravity anomalies; time variable gravity](#)
 - 91.25.-r [Geomagnetism and paleomagnetism; geoelectricity](#)
 - 91.25.Cw [Origins and models of the magnetic field; dynamo theories](#)
 - 91.25.Le [Time variations in geomagnetism](#)

- 91.25.Mf [Magnetic field reversals: process and timescale](#)
 - 91.25.Qi [Geoelectricity, electromagnetic induction, and telluric currents](#)
 - 91.25.St [Magnetic fabrics and anisotropy](#)
 - 91.30.-f [Seismology](#)
 - 91.30.Cd [Body wave propagation](#)
 - 91.30.Dk [Seismicity](#)
 - 91.30.Nw [Tsunamis](#)
 - 91.30.Px [Earthquakes](#)
 - 91.32.De [Crust and lithosphere](#)
 - 91.35.-x [Earth's interior structure and properties](#)
 - 91.35.Dc [Heat flow; geothermy](#)
 - 91.35.Ed [Structure of the Earth's interior below the upper mantle](#)
 - 91.35.Gf [Structure of the crust and upper mantle](#)
 - 91.35.Lj [Composition and state of the Earth's interior](#)
 - 91.40.Jk [Magma migration](#)
 - 91.60.Np [Permeability and porosity](#)
 - 91.60.Pn [Magnetic and electrical properties](#)
 - 91.65.Ej [Extrusive structures and rocks](#)
 - 91.65.Gk [Intrusive structures and rocks](#)
 - 91.67.-y [Geochemistry](#)
- 92.00.00 [Hydrospheric and atmospheric geophysics](#)
- 92.05.Hj [Physical and chemical properties of seawater \(salinity, density, temperature\)](#)
 - 92.10.-c [Physical oceanography](#)
 - 92.10.Fj [Upper ocean and mixed layer processes](#)
 - 92.10.Hm [Ocean waves and oscillations](#)
 - 92.10.Lq [Turbulence, diffusion, and mixing processes in oceanography](#)
 - 92.10.Ns [Fine structure and microstructure in oceanography](#)
 - 92.10.Vz [Underwater sound](#)
 - 92.10.ab [General circulation](#)
 - 92.10.ak [Eddies and mesoscale processes](#)
 - 92.40.Zg [Hydrometeorology, hydroclimatology](#)
 - 92.60.-e [Properties and dynamics of the atmosphere; meteorology](#)
 - 92.60.Aa [Modeling and model calibration](#)
 - 92.60.Bh [General circulation](#)
 - 92.60.Ek [Convection, turbulence, and diffusion](#)
 - 92.60.Fm [Boundary layer structure and processes](#)
 - 92.60.H- [Atmospheric composition, structure, and properties](#)
 - 92.60.Hp [Chemical composition and chemical interactions](#)
 - 92.60.Jq [Water in the atmosphere](#)
 - 92.60.Ls [Ion chemistry of the atmosphere](#)
 - 92.60.Mt [Particles and aerosols](#)
 - 92.60.Nv [Cloud physics and chemistry](#)
 - 92.60.Pw [Atmospheric electricity, lightning](#)
 - 92.60.Qx [Storms](#)
 - 92.60.Ry [Climatology, climate change and variability](#)
 - 92.60.Sz [Air quality and air pollution](#)
 - 92.60.Ta [Electromagnetic wave propagation](#)

- 92.60.Vb [Radiative processes, solar radiation](#)
 - 92.60.Wc [Weather analysis and prediction](#)
 - 92.60.Xg [Stratosphere/troposphere interactions](#)
 - 92.60.hc [Mesospheric composition, energy deposition, constituent transport and chemistry](#)
 - 92.60.hd [Stratospheric composition and chemistry](#)
 - 92.60.hf [Tropospheric composition and chemistry, constituent transport and chemistry](#)
 - 92.60.hh [Acoustic gravity waves, tides, and compressional waves](#)
 - 92.60.hk [Convection, turbulence, and diffusion](#)
 - 92.60.hv [Pressure, density, and temperature](#)
 - 92.60.hw [Airglow and aurorae](#)
 - 92.70.Gt [Climate dynamics](#)
 - 92.90.+x [Other topics in hydrospheric and atmospheric geophysics](#)
- 93.00.00 Geophysical observations, instrumentation, and techniques
- 93.30.Bz [Africa](#)
 - 93.30.Db [Asia](#)
 - 93.85.+q [Instrumentation and techniques for geophysical research](#)
 - 93.85.-q [Instruments and techniques for geophysical research: Exploration geophysics](#)
 - 93.85.Jk [Magnetic and electrical methods](#)
- 94.00.00 Physics of the ionosphere and magnetosphere
- 94.05.-a [Space plasma physics](#)
 - 94.05.Dd [Radiation processes](#)
 - 94.05.Jq [Spacecraft sheaths, wakes, and charging](#)
 - 94.05.Sd [Space weather](#)
 - 94.10.-s [Physics of the neutral atmosphere](#)
 - 94.10.Lf [Convection, diffusion, mixing, turbulence, and fallout](#)
 - 94.20.-y [Physics of the ionosphere](#)
 - 94.20.Ac [Auroral ionosphere](#)
 - 94.20.Bb [Wave propagation](#)
 - 94.20.D- [Ionospheric structure, composition](#)
 - 94.20.Fg [Plasma temperature and density](#)
 - 94.20.Ss [Electric fields; current system](#)
 - 94.20.Tt [Ionospheric soundings; active experiments](#)
 - 94.20.Vv [Ionospheric disturbances, irregularities, and storms](#)
 - 94.20.Xa [Meteor-trail physics](#)
 - 94.20.de [D region](#)
 - 94.20.dg [E region](#)
 - 94.20.dj [F region](#)
 - 94.20.dk [Polar cap ionosphere](#)
 - 94.20.dv [Ion chemistry and composition; ionization mechanisms](#)
 - 94.20.wc [Plasma motion; plasma convection; particle acceleration](#)
 - 94.20.wf [Plasma waves and instabilities](#)
 - 94.20.wh [Ionosphere/magnetosphere interactions](#)
 - 94.20.wj [Wave/particle interactions](#)
 - 94.20.wl [Plasma interactions with dust and aerosols](#)
 - 94.20.wq [Solar radiation and cosmic ray effects](#)

- 94.20.ws [Electromagnetic wave propagation](#)
 - 94.30.-d [Physics of the magnetosphere](#)
 - 94.30.Aa [Auroral phenomena in magnetosphere](#)
 - 94.30.Hn [Energetic trapped particles](#)
 - 94.30.Kq [Electric fields, field-aligned currents and current systems, and ring currents](#)
 - 94.30.Lr [Magnetic storms, substorms](#)
 - 94.30.Ms [Magnetic pulsations](#)
 - 94.30.Ny [Energetic particle precipitation](#)
 - 94.30.Tz [Electromagnetic wave propagation](#)
 - 94.30.Va [Magnetosphere interactions](#)
 - 94.30.Xy [Radiation belts](#)
 - 94.30.cg [Magnetospheric cusp](#)
 - 94.30.ch [Magnetopause](#)
 - 94.30.cl [Magnetotail](#)
 - 94.30.cq [MHD waves, plasma waves, and instabilities](#)
 - 94.30.cs [Plasma motion; plasma convection](#)
 - 94.30.cv [Plasmasphere](#)
 - 94.80.+g [Instrumentation for space plasma physics, ionosphere, and magnetosphere](#)
- 95.00.00 [Fundamental astronomy and astrophysics; instrumentation, techniques, and astronomical observations](#)
- 95.10.-a [Fundamental astronomy](#)
 - 95.10.Ce [Celestial mechanics](#)
 - 95.10.Eg [Orbit determination and improvement](#)
 - 95.10.Jk [Astrometry and reference systems](#)
 - 95.10.Km [Ephemerides, almanacs, and calendars](#)
 - 95.30.-k [Fundamental aspects of astrophysics](#)
 - 95.30.Cq [Elementary particle processes](#)
 - 95.30.Dr [Atomic processes and interactions](#)
 - 95.30.Gv [Radiation mechanisms; polarization](#)
 - 95.30.Jx [Radiative transfer; scattering](#)
 - 95.30.Ky [Atomic and molecular data, spectra, and spectral parameters \(opacities, rotation constants, line identification, oscillator strengths, gf values, transition probabilities, etc.\)](#)
 - 95.30.Lz [Hydrodynamics](#)
 - 95.30.Qd [Magnetohydrodynamics and plasmas](#)
 - 95.30.Sf [Relativity and gravitation](#)
 - 95.30.Tg [Thermodynamic processes, conduction, convection, equations of state](#)
 - 95.30.Wi [Dust processes \(condensation, evaporation, sputtering, mantle growth, etc.\)](#)
 - 95.35.+d [Dark matter](#)
 - 95.40.+s [Artificial Earth satellites](#)
 - 95.45.+i [Observatories and site testing](#)
 - 95.55.-n [Astronomical and space-research instrumentation](#)
 - 95.55.Br [Astrometric and interferometric instruments](#)
 - 95.55.Cs [Ground-based ultraviolet, optical and infrared telescopes](#)
 - 95.55.Ev [Solar instruments](#)
 - 95.55.Fw [Space-based ultraviolet, optical, and infrared telescopes](#)

- 95.55.Jz [Radio telescopes and instrumentation; heterodyne receivers](#)
- 95.55.Ka [X- and \$\gamma\$ -ray telescopes and instrumentation](#)
- 95.55.Qf [Photometric, polarimetric, and spectroscopic instrumentation](#)
- 95.55.Vj [Neutrino, muon, pion, and other elementary particle detectors; cosmic ray detectors](#)
- 95.55.Ym [Gravitational radiation detectors; mass spectrometers; and other instrumentation and techniques](#)
- 95.75.-z [Observation and data reduction techniques; computer modeling and simulation](#)
- 95.75.De [Photography and photometry \(including microlensing techniques\)](#)
- 95.75.Fg [Spectroscopy and spectrophotometry](#)
- 95.75.Kk [Interferometry](#)
- 95.75.Mn [Image processing \(including source extraction\)](#)
- 95.75.Qr [Adaptive and segmented optics](#)
- 95.80.+p [Astronomical catalogs, atlases, sky surveys, databases, retrieval systems, archives, etc.](#)
- 95.85.-e [Astronomical observations \(additional primary heading\(s\) must be chosen with these entries to represent the astronomical objects and/or properties studied\)](#)
- 95.85.Bh [Radio, microwave \(>1 mm\)](#)
- 95.85.Fm [Submillimeter \(300 \$\mu\$ m-1 mm\)](#)
- 95.85.Jq [Near infrared \(0.75-3 \$\mu\$ m\)](#)
- 95.85.Pw [\$\gamma\$ -ray](#)
- 95.85.Ry [Neutrino, muon, pion, and other elementary particles; cosmic rays](#)
- 95.85.Sz [Gravitational radiation, magnetic fields, and other observations](#)
- 96.00.00 [Solar system; planetology](#)
 - 96.10.+i [General; solar nebula; cosmogony](#)
 - 96.12.-a [Planetology of solid surface planets](#)
 - 96.12.Bc [Origin and evolution](#)
 - 96.12.De [Orbital and rotational dynamics](#)
 - 96.12.Fe [Gravitational fields](#)
 - 96.12.Hg [Magnetic field and magnetism](#)
 - 96.12.Jt [Atmospheres](#)
 - 96.12.Kz [Surfaces](#)
 - 96.12.Ma [Composition](#)
 - 96.12.Pc [Interiors](#)
 - 96.15.De [Orbital and rotational dynamics](#)
 - 96.15.Ef [Gravitational fields](#)
 - 96.15.Gh [Magnetic field and magnetism](#)
 - 96.15.Hy [Atmospheres](#)
 - 96.15.Uv [Rings and dust](#)
 - 96.20.-n [Moon](#)
 - 96.20.Dt [Features, landmarks, mineralogy, and petrology](#)
 - 96.20.Jz [Gravitational field, selenodesy, and magnetic fields](#)
 - 96.25.-f [Planetology of comets and small bodies](#)
 - 96.25.De [Orbital and rotational dynamics](#)
 - 96.25.Hs [Composition](#)

- 96.25.Qr [Interactions with solar wind plasma and fields](#)
- 96.25.St [Plasma and MHD instabilities](#)
- 96.25.Tg [Radiation and spectra](#)
- 96.30.-t [Solar system objects](#)
- 96.30.Cw [Comets](#)
- 96.30.Dz [Mercury](#)
- 96.30.Ea [Venus](#)
- 96.30.Gc [Mars](#)
- 96.30.Hf [Martian satellites](#)
- 96.30.Kf [Jupiter](#)
- 96.30.Mh [Saturn](#)
- 96.30.Pj [Uranus](#)
- 96.30.Qk [Uranian satellites](#)
- 96.30.Vb [Dust, extraterrestrial materials](#)
- 96.30.Wr [Planetary rings](#)
- 96.30.Ys [Asteroids, meteoroids](#)
- 96.30.Za [Meteors, meteorites and tektites](#)
- 96.40.Fg [Energetic solar particles and photons](#)
- 96.50.-e [Interplanetary physics](#)
- 96.50.Bh [Interplanetary magnetic fields](#)
- 96.50.Ci [Solar wind plasma; sources of solar wind](#)
- 96.50.Dj [Interplanetary dust and gas](#)
- 96.50.Ek [Heliopause and solar wind termination](#)
- 96.50.Fm [Planetary bow shocks; interplanetary shocks](#)
- 96.50.Gn [Comets](#)
- 96.50.Qx [Corotating streams](#)
- 96.50.S- [Cosmic rays](#)
- 96.50.Tf [MHD waves; plasma waves, turbulence](#)
- 96.50.Vg [Energetic particles](#)
- 96.50.Xy [Heliosphere/interstellar medium interactions](#)
- 96.50.sb [Composition, energy spectra and interactions](#)
- 96.50.sd [Extensive air showers](#)
- 96.50.sf [Interactions with terrestrial matter](#)
- 96.50.sh [Interplanetary propagation and effects](#)
- 96.60.-j [Solar physics](#)
- 96.60.Bn [Diameter, rotation, and mass](#)
- 96.60.Fs [Composition](#)
- 96.60.Hv [Electric and magnetic fields, solar magnetism](#)
- 96.60.Iv [Magnetic reconnection](#)
- 96.60.Jw [Solar interior](#)
- 96.60.Ly [Helioseismology, pulsations, and shock waves](#)
- 96.60.Mz [Photosphere](#)
- 96.60.Na [Chromosphere](#)
- 96.60.P- [Corona](#)
- 96.60.Q- [Solar activity](#)
- 96.60.Qc [Sunspots, faculae, plages](#)
- 96.60.Rd [Flares, bursts, and related phenomena](#)
- 96.60.Se [Prominences](#)
- 96.60.Tf [Solar electromagnetic emission](#)
- 96.60.Ub [Solar irradiance](#)
- 96.60.Vg [Particle emission, solar wind](#)
- 96.60.pf [Coronal loops, streamers](#)

- 96.60.qd [Sun spots, solar cycles](#)
 - 96.60.qe [Flares](#)
 - 96.90.+c [Other topics on the Solar system and planetology](#)
- 97.00.00 Stars
- 97.10.–q [Stellar characteristics and properties](#)
 - 97.10.Bt [Star formation](#)
 - 97.10.Cv [Stellar structure, interiors, evolution, nucleosynthesis, ages](#)
 - 97.10.Ex [Stellar atmospheres \(photospheres, chromospheres, coronae, magnetospheres\); radiative transfer; opacity and line formation](#)
 - 97.10.Fy [Circumstellar shells, clouds, and expanding envelopes; circumstellar masers](#)
 - 97.10.Gz [Accretion and accretion disks](#)
 - 97.10.Kc [Stellar rotation](#)
 - 97.10.Ld [Magnetic and electric fields; polarization of starlight](#)
 - 97.10.Nf [Masses](#)
 - 97.10.Ri [Luminosities; magnitudes; effective temperatures, colors, and spectral classification](#)
 - 97.10.Sj [Pulsations, oscillations, and stellar seismology](#)
 - 97.10.Tk [Abundances, chemical composition](#)
 - 97.10.Vm [Distances, parallaxes](#)
 - 97.20.–w [Normal stars \(by class\): general or individual](#)
 - 97.20.Ec [Main-sequence: early-type stars \(O and B\)](#)
 - 97.20.Li [Giant and subgiant stars](#)
 - 97.20.Pm [Supergiant stars](#)
 - 97.20.Rp [Faint blue stars](#)
 - 97.21.+a [Pre-main sequence objects, young stellar objects](#)
 - 97.30.Dg [Low-amplitude blue variables \(alpha Cygni, beta Cephei, delta Scuti, delta Delphini, delta Canis Majoris, SX Phoenicis, etc.\)](#)
 - 97.30.Eh [Emission-line stars \(Of, Be, Luminous Blue Variables, Wolf-Rayet, etc.\)](#)
 - 97.30.Fi [Chemically peculiar stars \(Ap, Am, etc.\)](#)
 - 97.30.Kn [RR Lyrae stars; RV Tauri and PV Telescopii variables](#)
 - 97.30.Nr [Flare stars \(UV Ceti, RS Canum Venaticorum, FU Orionis, R Coronae Borealis variables, etc.\)](#)
 - 97.30.Qt [Novae, dwarf novae, recurrent novae, and other cataclysmic](#)
 - 97.60.Bw [Supernovae](#)
 - 97.60.Gb [Pulsars](#)
 - 97.60.Jd [Neutron stars](#)
 - 97.60.Lf [Black holes](#)
 - 97.80.–d [Binary and multiple stars](#)
 - 97.80.Fk [Spectroscopic binaries; close binaries](#)
 - 97.80.Gm [Cataclysmic binaries](#)
 - 97.80.Hn [Eclipsing binaries](#)
 - 97.80.Jp [X-ray binaries](#)
- 98.00.00 Stellar systems; interstellar medium; galactic and extragalactic objects and systems; the universe
- 98.35.–a [Characteristics and properties of the Milky Way galaxy](#)
 - 98.35.Ac [Origin, formation, evolution, age, and star formation](#)

- 98.35.Df [Kinematics, dynamics, and rotation](#)
- 98.35.Eg [Electric and magnetic fields](#)
- 98.35.Hj [Spiral arms and galactic disk](#)
- 98.35.Jk [Galactic center, bar, circumnuclear matter, and bulge \(including black hole and distance measurements\)](#)
- 98.38.-j [Interstellar medium \(ISM\) and nebulae in Milky Way](#)
- 98.38.Am [Physical properties \(abundances, electron density, magnetic fields, scintillation, scattering, kinematics, dynamics, turbulence, etc.\)](#)
- 98.38.Bn [Atomic, molecular, chemical, and grain processes](#)
- 98.38.Er [Interstellar masers](#)
- 98.38.Jw [Infrared emission](#)
- 98.38.Kx [Intercloud medium \(ICM\); hot and highly ionized gas; bubbles](#)
- 98.38.Ly [Planetary nebulae](#)
- 98.38.Mz [Supernova remnants](#)
- 98.52.Nr [Spiral galaxies](#)
- 98.54.-h [Quasars; active or peculiar galaxies, objects, and systems](#)
- 98.54.Aj [Quasars](#)
- 98.54.Cm [Active and peculiar galaxies and related systems \(including BL Lacertae objects, blazars, Seyfert galaxies, Markarian galaxies, and active galactic nuclei\)](#)
- 98.54.Ep [Starburst galaxies and infrared excess galaxies](#)
- 98.54.Gr [Radio galaxies](#)
- 98.56.Si [Magellanic Clouds and other irregular galaxies](#)
- 98.56.Wm [Dwarf galaxies \(elliptical, irregular, and spheroidal\)](#)
- 98.58.-w [Interstellar medium \(ISM\) and nebulae in external galaxies](#)
- 98.58.Bz [Atomic, molecular, chemical, and grain processes](#)
- 98.58.Ca [Interstellar dust grains; diffuse emission; infrared cirrus](#)
- 98.58.Db [Molecular clouds, H₂ clouds, dense clouds, and dark clouds](#)
- 98.58.Hf [H II regions; emission and reflection nebulae](#)
- 98.58.Kh [Intercloud medium \(ICM\); hot and highly ionized gas; bubbles](#)
- 98.58.Li [Planetary nebulae](#)
- 98.58.Mj [Supernova remnants](#)
- 98.62.Ai [Origin, formation, evolution, age, and star formation](#)
- 98.62.Dm [Kinematics, dynamics, and rotation](#)
- 98.62.Gq [Galactic halos](#)
- 98.62.Hr [Spiral arms and bars; galactic disks](#)
- 98.62.Js [Galactic nuclei \(including black holes\), circumnuclear matter, and bulges](#)
- 98.62.Mw [Infall, accretion, and accretion disks](#)
- 98.62.Py [Distances, redshifts, radial velocities; spatial distribution of galaxies](#)
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 - 98.70.–f [Unidentified sources of radiation outside the Solar System](#)
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