

Subject Index

- ab-initio quantum chemistry, 50
 absorption spectroscopy, 37–41
 accretion disk, 452
 accretion rate, 226
 acetylenic species, 331, 351, 402–404, 412, 512
 acid, 30, 35, 397
 actanoids, 23
 action integral, 229, 230
 activity, non-ideal behavior, 142, 147
 adduct formation, 304, 312
 AGB, 402, 542, 549, 604–609
 AGN toroid, 11
 AIB, *see* Aromatic Infrared Band
 albite, 487, 488
 alcohols, 7, 31, 34, 35, 397, 398
 aldehydes, 7, 31, 34, 35, 397, 398, 479, 508
 aliphatic group, 580, 584
 alkali halides, 219
 alkali metals, 23
 alkaline, 30
 alkaline earth metals, 23
 alkanes, 31, 32, 397, 402
 alkenes, 31, 32, 183, 261, 397, 402
 alkynes, 31, 32, 183, 397, 402
 aluminum oxide, 145, 146, 148, 487, 488
 ambipolar diffusion, 383, 392, 394, 407, 455
 ambipolar diffusion timescale, 455
 AME, 356, 598–604
 amides, 36, 397
 amines, 7, 36
 amino acids, 5, 7, 8, 31, 36, 479, 507–509
 amorphous silicates, 221
 amorphous solid water, 213, 215–221, 419
 angular momentum transport, 452
 anharmonicity, 62, 76, 78, 90, 92, 123, 277, 286–288,
 297, 577, 581, 596, 597
 anion, 198, 200, 301, 305, 330, 344–347, 397, 398,
 407, 408, 415
 anomalous microwave emission, *see* AME
 anorthite, 487, 488
 apolar species, 33
 appearance energy, 293, 299, 302
 arenes, 33
 aromatic hydrocarbons, 5, 7, 33
 Aromatic Infrared Band, 258, 568–576, 592
 Aromatic Infrared Band, assignments, 578
 Aromatic Infrared Band, plateau emission, 573, 574
 Aromatic Infrared Band, profiles, 569–572,
 575, 581
 Aromatic Infrared Band, spectral fits, 575, 576
 Aromatic Infrared Band, strength variation,
 572, 573
 aromatic molecules, 397
 aromaticity, 260–263
 Arrhenius law, 291
 astrobiology, 2, 4
 asymmetric top, 60, 64, 84, 118
 atomic force microscope (AFM), 46, 51
 atomic number, 21, 23–25
 aufbau principle, 22, 29
 autoionization, 193, 198, 269, 300

 B3LYP functional, 52
 backward reaction, 142
 bandhead, 83
 Barnard cloud, 380
 base, 30, 36
 beam filling factor, 117
 Belousov-Zhabotinsky reaction, 204
 bimolecular reaction, 155
 binding energy, 217–222, 262, 420
 bistability, 204, 416, 417, 514
 black hole, 548
 Bok globule, 375–377, 380, 381, 392, 398, 412, 432,
 455, 458, 459
 Boltzmann diagram, *see* rotation diagram
 Boltzmann distribution, 101, 116, 157, 182, 186,
 274, 542

- Bonnor-Ebert sphere, 377, 383, 384, 455–458
 Born-Oppenheimer approximation, 48, 49, 87
- C-C bond length, 261
 C₂ Phillips/Mulliken system, 324
 CAI (calcium aluminum inclusion), 3, 489, 494
 canonical ensemble, 273–280, 284
 carbon chain, 198, 200, 398, 400, 402–404, 414, 415
 carbon chemistry, 331, 332, 400
 carbon cluster, 529
 carbonyl, 31, 34–36
 carboxylic acid, 5, 7, 35, 36
 cascade, 250, 251
 cavity ringdown spectroscopy, 37, 38
 centrifugal distortion, 61–63, 82
 champagne flow, 388
 chaotic behavior, 204
 chemical bifurcation, 204, 416, 417, 514
 chemical bond properties, 32
 chemical clock, 475
 chemical composition, 202, 203
 chemical desorption, 243, 244
 chemical formula, 26
 chemical potential, 136, 138–142
 chemical thermodynamics, 134–150, 487–489
 chemical timescale, 149, 150
 chemiluminescence, 237
 chemisorption, 218–220, 222, 528
 chlathrate, 241, 420, 485
 chromophore, 88, 89
 circumnuclear disk, 11
 classical nucleation theory, 149
 cloud collapse, 13, 16, 454–460
 CO emission, 11–13, 15, 380–385
 CO-dark molecular gas, 12, 380, 381
 coagulation, 163, 164, 174, 466, 477, 485, 486, 489, 496, 608
 collisional deexcitation, 104–107
 color excess, 377
 comet, 6, 10, 17, 18, 414, 507–509
 complex organic molecules (COMs), 461, 470–481
 condensation sequence, 145–148, 487, 488
 configuration interaction, 50, 106
 converging flows, 380, 384, 386, 394, 402, 408
 coronene family, 262, 278, 281
 corundum, 145, 146, 148, 487, 488
 cosmic microwave background, 325
 cosmic ray, 154–156, 190–194, 213, 390, 407–411, 487
 cosmic ray, cross section, 190, 191
 cosmic ray, desorption, 246–248, 437, 459
 cosmic ray, flux, 182, 190, 191
 cosmic ray, heating, 367, 390, 391, 394, 410, 511, 512
 cosmic ray, ionization, 154–156, 190–194, 330–333, 342–347, 367, 390, 400, 407–411, 416, 475, 493, 494, 512, 614
 cosmic ray, ionization rate, 172, 173, 191, 342–347
 cosmic ray, penetration, 410, 411
 cosmic ray, produced photons, 156, 172–174, 400, 402, 413, 435, 459, 460, 477, 507, 541
 Coupled cluster method, 51, 106
 covalent bond, 25, 29
 CRESU technique, 42, 107
 critical density, 72, 102–104, 112, 113, 116, 118, 120, 121, 323, 368, 370, 371, 536, 542
 crossed molecular beam experiment, 43
 crystalline silicates, 221
 crystallization, 241, 420, 430
 cubic ice, 420
 curve of growth, 92, 109–112, 127, 128, 321
 cyanic acid, 397
 cyanide, 36, 398
 cyanoacetylene, 403
 cyanopolyynes, 31, 402–404, 605
 cyclic molecules, 397
- dark cores, 211, 213, 244, 320, 452, 455
 Debye frequency, 215
 Debye law, 281
 delayed fluorescence, 268, 269
 density functional theory (DFT), 51, 52, 262
 density functional theory, *see* DFT
 density of states, 160, 185–188, 197, 265–268, 275–280
 depletion, 213, 214, 409, 414, 416, 432–438, 459, 460
 depletion timescale, 215
 desorption, 211, 239–248
 detailed balance, 103, 187, 198, 199
 deuterium chemistry, 345, 346, 404–407, 428–430
 deuterium fractionation, 404–407, 428–430, 469, 470, 473, 506, 507, 541
 deuteron transfer, 405, 406
 DFT, 51, 52, 219, 577
 diagnostic diagrams, 120–124
 DIBs, 58, 258, 319, 320, 347–357
 DIBs, abundance, 350–352
 DIBs, equivalent width, 348, 351
 DIBs, profile, 349, 354–357, 600
 dielectronic recombination, 193
 diffuse cloud, 11, 202, 210, 212, 318–357, 367, 368, 380, 396, 409, 451, 452, 510, 512, 593, 602, 615–620
 diffuse cloud, characteristics, 11, 320–325
 diffuse cloud, chemistry, 329–347
 diffuse interstellar bands, *see* DIBs
 diffusion limit, 213, 232, 238, 248–252
 diffusion rate, 222–224
 diopside, 487, 488
 dipole, 177, 178
 dipole moment, 26, 74, 177, 198
 dipole-dipole interaction, 244
 Doppler profile, 108, 110–112
 Doppler, core, 108, 127
 Doppler, parameter, 108, 109

- Doppler, width, 108
 dust surface area, 214
 dust-gas collisions, 390–392, 394
 dust, accretion, 213, 214, 367, 433, 434, 459, 460
 dust, aggregates, 452, 485, 486
 dust, attenuation, 452, 510–512
 dust, column density, 376–378
 dust, emission, 375, 458, 463, 465, 466
 dust, extinction, 161–164
 dust, formation, 607–609
 dust, fragmentation, 610
 dust, grain-grain collisions, 610
 dust, porous, 485, 486
 dust, soot, 607, 608
 dust, spectral energy distribution, 375, 377, 378
 dust, spinning grains, 598–604
 dust, suprathermal excitation, 603
 dust, temperature, 434, 514
- early universe chemistry, 200, 327
 Eckart potential, 229–231
 Eddington, 1
 effective mass, 230, 231
 Einstein coefficient, 72–74, 102, 103, 107, 108, 111, 112
 electron affinity, 25, 182, 198, 199, 299, 301, 302, 305, 306
 electron attachment, 197–200
 electron configuration, 22–24, 92, 95
 electron density distribution, 22, 33
 electron sticking efficiency, 198
 electronegativity, 25, 33, 37, 92, 95, 348
 electronic excitation, 124–128, 201, 265–270
 electronic fluorescence, 258, 264–270, 309
 electronic spectroscopy, 86–89, 265–270
 electronic transition, 58, 90, 92, 95, 173–270, 321, 323, 347–357
 electrophile, 30, 31, 36, 37
 elements, 21, 23–25
 Elly-Rideal process, 211, 529
 emissivity, 103
 endogeneous delivery, 5–8
 endohedral, 33
 energy balance, 367
 energy cascade, 285–288, 297
 energy fluctuations, 274, 275
 energy gap law, 265–267, 350, 355
 energy levels, 21
 enstatite, 147, 149, 487, 488
 enthalpy, 134–136, 141, 160, 180, 218,
 entropy, 135–137, 143, 274
 equilibrium constant, 139, 140, 144–147
 equivalent width, 127, 128
 ergodic hypothesis, 53, 187, 269, 279, 297, 298, 300
 escape probability, 107–112, 170, 370
 ester, 35, 397
 ethers, 34, 397, 398
- ethyl group, 580
 evaporation rate, 226, 228
 excitation temperature, 71, 103, 116–118, 323, 370–372, 376, 378
 exogeneous delivery, 5–8
 exohedral, 33
 exoplanets, 2, 9, 11
 exothermic, 175, 181
 extinction, 161–164, 349, 376, 377, 452
- FALP technique, 44
 feldspar, 487, 488
 fine-structure level, 201
 finite heat bath correction, 279, 290
 Fischer-Tropsch process, 210, 489
 forsterite, 147, 149, 487, 488
 forward reaction, 142
 Fourier transform spectrometer, *see* FTS
 fractionation, 404–407, 411–415, 428–430, 506, 507
 Franck-Condon factor, 87, 88, 90, 159, 181, 196, 266–268, 357
 freeze out, 434, 487, 490, 492, 499, 505, 513
 FTS, 37, 38
 fugacity, 140, 141
 fullerene, fragmentation, 310
 fullerenes, 33, 258, 308–312, 397, 593, 594, 610, 611
 fullerenes, fluorescence, 309
 fullerenes, ionization potential, 299, 310
 fullerenes, phosphorescence, 309
 fullerenes, photo-ionization yield, 310
 fullerenes, size, 309, 311
- galactic nuclei, 90, 568
 gas phase, chemical processes, 154–204
 gas phase, chemical rules, 202
 gas phase, chemistry network, 202–204
 gas phase, models, 202, 203
 gas-grain interaction, 418–438, 459, 460
 Gaussian profile, 108, 110–112
 giant molecular cloud (GMC), 380, 385
 Gibbs free energy, 135–139
 grain surface chemistry, 202, 210–252, 400, 401, 418–432, 490–492
 grandPAH, 263, 351, 352, 592, 593, 604
 graphene, 260, 272, 273, 299, 307, 309, 608, 610, 617
 graphite, 219, 272, 281, 307, 392, 528, 610
 gravitational heating, 391, 392, 394
- H-roaming, 293
 H₂, abundance, 325, 326
 H₂, dissociation front, 171, 327
 H₂, excitation, 515, 518
 H₂, fluorescence, 323, 515–518
 H₂, formation, 170, 325–329, 527–530, 534, 546
 H₂, formation timescale, 327

- H₂, Lyman-Werner bands, 90, 111, 121, 125, 128, 162, 168, 169, 172, 173, 201, 318, 319, 321, 323, 413
- H₂, ortho-para ratio, 333, 401, 414, 515–518
- H₂, self shielding, 168–172, 326
- H₂, UV pumping, 515–518, 528
- Habing field, 163, 391, 512
- habitable zone, 2, 4, 481, 487
- HACA mechanism, 149, 607
- halogen chemistry, 337, 338
- halogens, 23
- hamiltonian, 48–50, 275
- harmonic oscillator, 61, 75, 78, 143, 156, 275–277
- Harris-Kasemo process, 211, 226, 237, 427
- Hartree-Fock, 49–52
- heat capacity, 277, 279, 284, 290
- Heisenberg uncertainty principle, 159, 286
- helium droplet technique, 39
- Herbig AeBe star, 452, 496, 502, 571, 572, 586
- heterocycle, 260
- hexagonal ice, 420
- HI, 21 cm line, 318, 319, 380
- HI, halos, 380
- HI, Lyman alpha, 318, 321
- HI/H₂ transition, 170–172, 366
- highest occupied molecular orbital (HOMO), 270–273, 309
- HII regions, 320, 325, 380, 568, 586, 593
- Hönl-London factor, 74
- Hooke's law, 75, 80
- hot atom diffusion, 211, 226, 237
- hot core/corino, 11, 123, 124, 212, 333, 368, 369, 398, 418, 424, 430, 459, 461–481, 492, 507–539
- Hückel's rule, 261
- Hund's rule, 22, 86
- hybridization, 27, 28, 34, 260
- hydrides, 397, 398
- hydrocarbon chain, 17, 351–353, 400, 402–404, 512, 531
- hydrogen bond, 35, 36, 219
- hydrogen-bonded network, 85
- hydrogenated amorphous carbon, 529, 530, 585, 592
- hydrogenated PAHs, 304, 577, 590, 591
- hydrogenation reaction, 228–235, 239, 248, 414, 425–427, 431, 471–473, 501
- hydroxyl, 31, 35
- hypercompact HII region, 454, 457
- hyperfine transition, 66
- ice band, 92, 418–423
- ice band, integrated strength, 85, 423
- ice band, profile, 419–422
- ice chemistry (see also, surface chemistry), 425–432
- ice mantle, 210, 367, 402, 418–432, 459, 460, 466, 469–481, 513
- ice mantle, composition, 418, 419, 423, 424, 506
- ice mantle, sublimation, 420, 469, 474–476
- ice mantles, sputtering, 213, 244–246, 469, 535, 537, 548
- ice mantles, sputtering yields, 245, 246
- ice, abundance, 423, 424, 430
- ice, column density, 422–424, 435
- ice, energetic processing, 18, 420, 424, 431, 469, 476–480, 541
- ice, residue, 479
- ice, segregation, 420, 481
- ice, surface, 236, 239
- ice, thermal polymerization, 18
- ice, thermal processing, 240–242, 424, 479, 541
- ice, UV processing, 420, 424, 469, 476–480
- infrared dark cloud, 454, 457
- initial mass function (IMF), 383, 384
- inside-out collapse, 456, 459, 460
- intermittent turbulent dissipation, 323, 324, 332, 338–343, 393
- internal conversion (IC), 264–270, 294
- internal vibrational redistribution (IVR), 264–270, 297, 298
- interstellar radiation field, 156, 320, 321
- intersystem crossing (ISC), 264–270, 296, 309
- inverse P Cygni profile, 13, 16, 458–460
- inversion transition, 372, 378
- ion trap, 44, 45
- ion-dip technique, 39
- ion-molecule chemistry, 17, 18, 175–181, 400, 459
- ionic bond, 25
- ionic compound, 25
- ionization front, 510, 520
- ionization parameter, 615, 618–620
- ionization potential, 24, 25, 298–301, 616–618
- IR (in)active mode, 76, 77
- iron, 487, 488
- isomer, 26
- isomerization, 294, 610, 611
- isothermal sphere, 455, 456
- isotope, 5, 6, 21
- isotopologue, 233, 234, 371, 375, 376, 404–407, 411–415, 428–430, 466, 491, 507
- Jablonski diagram, 265, 266
- Jahn-Teller effect, 353, 354
- Kekulé structure, 259
- Kelvin-Helmholtz instability, 533
- Kelvin-Helmholtz timescale, 453
- Kennicutt-Schmidt law, 13
- ketones, 7, 31, 34, 35, 397
- kinetic isotope effect, 229–232, 429, 469
- Knudsen diffusion, 224, 225
- Kolmogorov turbulence, 393
- laboratory technique, 34–48
- Lane-Emden equation, 456

- Langevin rate, 155, 156, 175–179, 181, 198, 200, 303–305
 Langmuir-Hinshelwood process, 211
 lanthanoids, 23
 large velocity gradient, 111, 395
 laser desorption, 47
 laser induced fluorescence, 38
 late heavy bombardment, 3, 5, 10, 506
 law of mass action, 139, 147
 level population, 101–120
 Lewis structure, 26
 line intensity, 101, 111–113
 line list, 84
 line profile, 108–111
 linear rotor, 60–62, 64
 local thermodynamic equilibrium (LTE), 71, 101–103, 112, 114
 London dispersion forces, 217
 lone electron pair, 27, 30
 Lorentzian profile, 100, 110–112
 lowest unoccupied molecular orbital (LUMO), 270–273, 309
- magnetic field, 392, 407, 497, 498
 magnetorotational instability, *see* MRI
 masers, 11, 541–552
 masers, action, 545, 550
 masers, CH₃OH, 551, 552
 masers, gain, 545
 masers, H₂CO, 552
 masers, H₂O, 543–548
 masers, NH₃, 552
 masers, OH, 548–551
 masers, OH main lines, 549
 masers, OH satellite lines, 549
 masers, physics, 542, 543
 masers, saturated, 544
 mass spectrometry, 39
 matrix isolation spectroscopy, 39–41, 576
 mean free path, 212
 melilite, 487, 488
 melting point, 191
 messenger technique, 39, 576
 meteorites, 3, 5–7, 19, 148, 414, 488, 489, 494, 505, 507–509
 methyl group, 31, 580, 584, 592
 methylene group, 584
 microcanonical ensemble, 273–280
 microcanonical heat capacity, 279
 microcanonical system, 53
 microcanonical temperature, 278, 279, 301
 microscopic reversibility, 142, 542
 modified black body, 378
 mole, 25, 134
 mole fraction, 141, 142
 molecular absorption, 100–128
 molecular abundances, 321–323, 398–400, 424, 432, 464, 469, 470, 522, 523, 539, 540
 molecular beam, 43
 molecular cloud, 11, 201, 210, 212, 225, 366–438, 451–454, 568
 molecular cloud, column density, 366, 367, 384, 385, 376–378, 388, 389
 molecular cloud, cooling, 394–396
 molecular cloud, degree of ionization, 392, 407–410
 molecular cloud, density, 11, 375–380, 385
 molecular cloud, distribution function, 382
 molecular cloud, energy balance, 367, 390–396, 452, 468
 molecular cloud, evolution, 386–388, 402
 molecular cloud, filament, 382, 383, 452
 molecular cloud, luminosity, 388
 molecular cloud, mass, 366, 384, 385
 molecular cloud, pressure, 368
 molecular cloud, probability density distribution, 385, 386
 molecular cloud, scaling relations, 384, 385
 molecular cloud, size, 11, 385
 molecular cloud, temperature, 11, 375–386
 molecular column density, 114–120
 molecular diagnostics, 120, 121
 molecular dynamics, 52–54, 216, 243
 molecular emission, 100–128
 molecular orbital theory, 28
 molecular orbitals, 28, 29
 molecular spectroscopy, 58–95
 moment of inertia, 59
 Monte Carlo, 250, 430, 431
 Morse potential, 62, 82
 MRI, 452, 482, 493–498
 multiphoton processes, 282–284
- Newton-Rhapson, 203
 nitrile, 31, 36, 37, 470
 nitrogen chemistry, 332–335, 400, 401
 noble gas matrices, 218, 225
 noble gasses, 23
 non-LTE effects, 201, 202, 204, 370
 nuclear spin, 69–71, 101
 nucleation, 149, 606, 607
 nucleophile, 30, 32, 33, 35–37
- OB Association, 386
 oblate symmetric top, 60, 63, 83
 olefins, 32, 33
 olivine, 147, 149, 482, 488
 optical depth, 107–112, 117
 organic acid, 31
 ortho states, 65, 66, 69–71, 90, 101
 ortho-to-para ratio, 16, 105, 201, 333, 401, 414, 515–518
 orthopyroxene, 147, 149, 487, 488

- oscillator strength, 73, 74, 87, 90, 156, 350–352
 ovalene family, 262
 oxidation reaction, 29, 424, 425, 427, 428
 oxidation reaction, 236, 237, 425
 oxide, 397
 oxygen chemistry, 330, 331, 400
- P branch, 82–84
 PAH cluster, 307, 308, 574, 585, 598, 599, 602, 603, 611, 615, 619
 PAHs, 12, 14, 17, 18, 58, 189, 190, 219, 258–308, 346, 347, 351–353, 356, 398, 407, 408, 480, 489, 501, 509, 511, 529–532
 PAHs, abundance, 597–599
 PAHs, anions, 299, 301, 346, 347, 604
 PAHs, armchair structure, 588
 PAHs, cation, 574, 579, 582, 584
 PAHs, CC stretching modes, 581–585
 PAHs, CCC bending modes, 588, 589
 PAHs, CH in-plane-bending modes, 581–585
 PAHs, CH out-of-plane bending modes, 585–588
 PAHs, CH stretching modes, 579–581
 PAHs, charge distribution, 616, 617
 PAHs, complex, 585
 PAHs, data base, 577, 591–593
 PAHs, dehydrogenation, 292–296, 305, 306
 PAHs, density of states, 278–280
 PAHs, derivative, 294–296
 PAHs, deuteration, 581, 592
 PAHs, dipole moment, 603
 PAHs, drumhead modes, 357, 589, 591
 PAHs, electronic absorption, 270–273
 PAHs, emission model, 280–288, 594–599
 PAHs, emission profile, 286–288
 PAHs, energy distribution function, 280–283
 PAHs, evolution, 604–615
 PAHs, far-IR, 589
 PAHs, fragmentation, 259, 264, 281, 283, 288–300, 529, 610–615
 PAHs, functional groups, 589–592, 610
 PAHs, ionization, 264, 298–300, 617, 618
 PAHs, IR emission spectrum, 285–288
 PAHs, jumping jack modes, 589, 591
 PAHs, life time, 614, 615
 PAHs, N-substitution, 583, 591, 592
 PAHs, neutral, 574, 582, 584
 PAHs, overtone, 581
 PAHs, photochemical evolution, 594
 PAHs, photochemistry, 288–298, 529, 604, 612, 613
 PAHs, processing by energetic ions, 604, 611–615
 PAHs, profile, 596, 597
 PAHs, protonation, 604
 PAHs, rotational emission, 598–604
 PAHs, size, 264, 595
 PAHs, superhydrogenation, 529, 577, 580
 PAHs, top-down chemistry, 610, 611
 PAHs, UV absorption rate, 264
 PAHs, vibrational spectroscopy, 576–592
 PAHs, zig-zag structure, 588
 palladium, 218
 para states, 65, 66, 69–71, 90, 101
 parker instability, 388
 partition function, 71, 72, 77, 78, 135, 138–140, 143, 239, 274–277
 Pauli exclusion principle, 49, 50, 69, 87, 90
 PDR, 11, 90, 201, 204, 213, 320, 329, 352, 366, 452, 459, 460, 489–492, 509–532, 574, 603, 615–620
 PDR, diagnostic diagram, 515, 518, 519
 PDR, structure, 510–514
 pebbles, 5, 6, 9
 pentagon, 294, 585, 603
 periodic table, 23–25
 perovskite, 487, 488
 pH, 30
 phenol, 34
 phonon modes, 244
 phosphonic acids, 7
 phosphorescence, 264–270, 309
 photo-chemistry, 158–175
 photo-desorption, 242, 243, 367, 434, 435, 437, 459, 490
 photo-dissociation, 92, 154–156, 158–160, 318–357
 photo-dissociation, cross section, 155, 159, 160, 199
 photo-dissociation, isotope selective, 491, 492, 500
 photo-dissociation, rate, 154–156, 160–174
 photo-electric heating, 318, 339, 367, 511, 512, 615–620
 photo-ionization, 165, 167, 168
 photodissociation region, *see* PDR
 phyllosilicate, 487, 488
 physisorption, 217, 222
 pi-electron, 260, 261
 planet formation, 452, 487, 502
 planetary nebula, 90, 258, 568, 571, 586, 604, 605
 planetesimals, 3, 5, 6, 9, 17, 18
 Poincare fluorescence, 268
 polarizability, 156, 157, 176–178, 181, 182, 198, 217, 219, 226, 302–308
 polycyclic aromatic hydrocarbons, *see* PAHs
 pores, 224, 225, 241, 420
 post AGB objects, 11, 568, 571, 577, 579, 584, 593, 604, 605, 609
 prebiotic species, 4–11
 predissociation, 158, 194
 presolar dust, 148
 prestellar core, 385, 392, 430, 454–460, 476
 prestellar core, density distribution, 383, 384, 455–457
 prestellar jet, 452, 454
 prolate symmetric top, 60, 63, 83
 proton affinity, 179, 180, 304, 312, 333, 434, 460, 475, 502
 proton transfer, 304, 331, 400, 401, 403, 408, 430, 434, 475

- protoplanetary disk, 8–11, 17, 18, 149, 150, 210, 319, 411, 457, 480, 481–506, 568
 protoplanetary disk, dead zone, 489
 protoplanetary disk, degree of ionization, 493–498
 protoplanetary disk, density, 482
 protoplanetary disk, dispersal timescale, 452, 501
 protoplanetary disk, dissipation timescale, 453
 protoplanetary disk, dust drift, 486
 protoplanetary disk, flaring, 484
 protoplanetary disk, incident radiation field, 490, 505
 protoplanetary disk, Keplerian rotation, 482
 protoplanetary disk, mass, 499–501
 protoplanetary disk, molecular abundances, 505
 protoplanetary disk, scale height, 482, 484
 protoplanetary disk, size, 482–484
 protoplanetary disk, structure, 481–486
 protoplanetary disk, temperature structure, 11, 484, 485
 protoplanetary disk, viscous heating, 484
 protoplanetary disk, α -parameter, 483, 504
 protostar, *see* young stellar objects
 protostellar jets, 452, 454, 457, 458, 532–541
 purines, 5, 7
 pyramidal carbon, 585
 pyrimidines, 5, 7
- Q branch, 82–84
 quadrupole moment, 201
 quantum chemistry, 48–54
 quantum numbers, 21, 22
- R branch, 82–84
 RADEX, 116–120
 radiation temperature, 114, 117
 radiative stabilization, 198, 200, 415
 radiative transfer equation, 114
 radical, 182, 202, 397
 RAIRS, 40, 46, 47
 rate equations, 202, 203, 248–252, 431
 Rayleigh Jeans temperature, 114
 reaction, acid/base, 30
 reaction, addition, 33
 reaction, associative detachment, 155, 200, 201, 305, 328
 reaction, charge transfer, 154, 155, 157, 180, 304, 305, 310, 312, 344, 345, 407
 reaction, collisional association, 155, 196
 reaction, collisional dissociation, 154, 196, 197
 reaction, condensation, 36, 403, 508
 reaction, cosmic ray ionization, 155, 190–194, 400
 reaction, dehydration, 35
 reaction, electron attachment, 197, 200, 299, 300, 302–303, 328, 347, 407
 reaction, electron detachment, 157, 300, 415
 reaction, electron recombination, 154, 155, 157, 194–197, 302, 303, 311, 330, 331, 337, 338, 342, 345, 400, 401, 403
 reaction, electron transfer reaction, 29
 reaction, insertion, 403
 reaction, ion-molecule, 17, 18, 42, 154, 155, 157, 175–181, 400–415
 reaction, isotope exchange, 404–407, 411–415
 reaction, mutual neutralization, 305, 330, 344–347, 408, 413, 415
 reaction, neutral-neutral, 18, 154, 155, 157, 181–184, 201, 306, 307, 400, 403
 reaction, photodissociation, 154, 155
 reaction, radiative association, 154, 155, 157, 184–190, 328, 331, 337, 415
 reaction, radiative recombination, 157, 330, 407
 reaction, redox, 29
 reaction, reduction, 29
 reaction, substitution, 33
 reaction, surface, 226–239
 reaction, ternary, 185, 186, 189, 196
 reaction, unimolecular, 155, 188
 reducing conditions, 469, 473, 474
 reflection absorption infrared spectroscopy, *see* RAIRS
 reflection nebula, 91, 320, 568, 586, 593, 611
 residence time, 226, 228
 resonance, 579, 580
 resonant two-color two-photon ionization, 39, 107
 rigid rotor, 59, 71, 81, 143
 ro-vibrational excitation, 125, 126
 ro-vibrational transition, 58, 81–84, 90, 92, 323
 rotation diagram, 14, 16, 116–120, 124, 128, 321, 323, 324, 368, 369, 379, 466, 467, 536, 542
 rotation-vibration interaction, 82
 rotational coupling, 185
 rotational degeneracy factor, 69–71
 rotational emissivity, 103
 rotational energy levels, 59–61, 63, 64, 67
 rotational frequency, 60, 63, 72, 90, 93, 95
 rotational partition function, 71, 72, 140, 143, 239
 rotational quantum number, 60
 rotational selection rules, 60, 63, 65, 66, 69, 83
 rotational spectroscopy, 41, 59–75
 rotational temperature, 73, 355, 356
 rotational transition, 58–75, 90, 92, 95
 RRK theory, 288
 RRKM theory, 288–291
 Rydberg state, 194, 196, 300
- Saha equation, 52
 salts, 397, 478–480
 scanning electron microscopy (SEM), 45
 scanning tunneling microscopy (STM), 45, 51
 Schrödinger equation, 48, 49
 SED, *see* dust, spectral energy distribution
 selected ion flow tube technique, *see* SIFT

- selection rules, 60, 63, 65, 66, 69, 83, 87, 90
 self consistent field method (SCF), 50
 self gravity, 366, 368, 377, 379, 380, 386, 393, 452
 self shielding, 168–172, 411
 shock, 90, 213, 244, 318, 320, 329, 339, 380, 393,
 407, 418, 463, 532–541, 546–548, 574
 shock, structure, 533–535
 short-lived radioactive nuclei, 494, 495
 SIFT, 41, 42, 196
 sigma bond, 27–29, 260, 261
 silica, 147, 149
 silicates, 216, 391, 419, 423, 487, 488
 snow line, 485, 487, 492, 499, 501, 502, 507
 solar nebula, 3, 505–509
 solid CO, 92, 419, 421, 422
 solid CO₂, 419–422
 solid compounds, 145
 solid state, energy transfer, 243, 244
 solution, 141, 142
 soot chemistry, 18, 604, 606–608
 sooting flame, 604, 606–608
 spectroscopy, 58–95
 spherical top, 60
 spin-orbit coupling, 67, 185
 spiral arm, 366, 380, 385, 386
 sputtering, 244–246, 430, 535
 standard state, 136, 137, 139
 star formation, 366, 451–551
 star formation, efficiency, 366
 star formation, rate, 12, 13
 statistical equilibrium, 102, 107
 statistical mechanics, 273–280
 statistical weight, 69–72, 77
 steady state, 203
 stellar ejecta, *see* stellar outflow
 stellar feedback, 318, 325, 380, 386–388, 519
 stellar outflow, 18, 210, 452, 454, 457, 458, 519,
 532–541
 sticking, 211, 212, 214–217, 328, 329
 stochastic surface chemistry, 248–252
 storage ring, 44, 196
 Strecker synthesis, 7, 8, 508
 structural formula, 26, 529, 260
 sublimation, 240–242, 246, 367, 420, 430, 436, 469,
 474–476, 487, 490, 492, 513
 subthermal excitation, 113, 120, 379
 sulfides, 397
 sulfur bearing species, 336, 337
 sulfur chemistry, 335–337
 sulphonic acids, 7
 superbubble, 386
 supernova, 318, 325, 380, 386–388, 494, 612–615
 superPAHs, 263, 264
 suprathreshold excitation, 114, 117, 120, 324, 536, 542
 surface chemistry, 45–48, 210–252, 333, 425–432
 surface chemistry, master equation, 250, 251
 surface chemistry, migration, 222–225, 228
 surface chemistry, migration rate, 222–224, 228
 surface chemistry, mobile species, 212
 surface free energy, 149
 surface reaction probability, 228, 229, 248
 surface reaction, abstraction, 231–234, 426–430,
 469, 471
 surface reaction, addition, 231–234, 426–430,
 469, 471
 surface reaction, radical-molecule, 228, 425
 surface reaction, radical-radical, 227, 425
 surface reactions, hot radical, 237
 surface reactions, tunneling, 229–236, 248
 surface, binding energy, 217–222, 226
 surface, coverage, 228, 248–252
 surface, distribution of binding sites, 220, 221,
 226, 420
 surface, hopping, 214, 222–226
 surface, mobility, 222–224, 248–252
 surface, processes, 213–226
 surface, reactions, 226–239, 425–432
 surface, structure, 218, 219, 431
 SWIFT pulse, 44
 symmetric top, 60, 63, 64, 74, 83, 371–374, 543

 T Tauri star, 452, 489, 490, 493, 496, 501–505
 TDR, 338–342, 524, 535
 temperature programmed desorption, *see* TPD
 thermal accommodation, 214–217, 226, 237, 238, 390
 thermal bath, 53
 thermal desorption, 213, 239–242
 thermal spike, 246
 thermo-ionic emission, 269, 300, 301, 310
 thermochemistry, 134–150, 606
 thermodynamics, 134, 135
 three level system, 114
 time-dependent chemistry, 401
 time-dependent evolution, 203
 top-down chemistry, 18, 610–614
 TPD, 46, 47, 219–221, 240–242
 trans isomer, 32
 transition metal, 23
 transition strength, 65, 72–75, 123
 translational partition function, 135, 140
 translucent clouds, 320, 321, 332, 380, 510, 512
 tunneling, 213, 222–224, 226, 229–236, 436
 turbulence, 318, 320, 323, 324, 338–343, 366, 368,
 380, 391, 393, 394, 402, 418, 455, 457, 469
 turbulent dissipation, 327, 332, 385
 turbulent dissipation regions, *see* TDR
 two level system, 102

 ultra luminous infrared galaxies (ULIRGs), 11, 568
 ultracompact HII regions, 454, 457, 548
 unimolecular dissociation, 160
 unimolecular dissociation, 266, 288–298
 Urey-Miller experiment, 7, 8, 509

- valence bond theory, 27
van der Waals complex, 182, 615
van der Waals interaction, 181, 217–219, 234, 236,
244, 306, 309, 420, 608–610
very small grains, 529, 598, 619
vibrational partition function, 77, 78, 140,
143, 239
vibrational spectroscopy, 75–85, 121, 123, 124, 577,
576–593, 594
vibrational spectroscopy, solid, 84, 85
vibrational temperature, 73, 78, 264
vibrational transition, 58, 76–81, 90, 92, 95, 121,
123, 124
virial theorem, 385, 388, 393
viscous dissipation, 452, 481, 482
Voigt profile, 109, 126, 127
warm intercloud medium, 318, 319
WKB, 222, 229, 231
Wolf-Rayet star, 494
X-rays, 487, 489, 490, 493, 494
X_{CO} factor, 388, 389
young stellar object, 210, 212, 368, 380, 402, 452,
532, 593
young stellar objects, infall, 13
young stellar objects, outflow, 11
zero point energy, 230, 404–407, 411–415, 429, 469
Λ doubling, 66–69, 549
π electrons, 26–29

Source Index

- AFGL 2688, 571
 AFGL 618, 605, 609
 Aquila molecular cloud, 383, 384
- B1-b, 464
 B2200+420, 322
 B68, 375–377, 381, 392, 398, 412, 432, 455, 458, 459
 b355, 16, 459
 BD+63 1964, 348
 BN/KL, *see* Orion BN/KL
- California molecular cloud, 388
 CD-42 11721, 586
 Cep E-mm, 369
 Comet 67P/Churyumov Gerasimenko, 509
 Compact Ridge, *see* Orion Compact Ridge
 CW Leo, *see* IRC+10216
 Cyg OB2 no 12, 322
 Cygn OB2 association, 387
 Cygnus X, 387
- DM Tau, 499, 505
 DR 21, 387
 EC 90, 423
- Elias (3-)16, 423, 424
 Elias 29, 424
- G10.6-0.4, 322
 GG Tau, 499
 GGD 27-ILL, 586
- Hale Bopp, 424
 HD 37097, 90
 HD 37903, 515–518
 HD 44179, *see* red rectangle
 HD 97048, 572
 HD 100546, 572
- HD 124314, 322
 HD 145502, 348
 HD 147165, 348
 HD 147683, 93
 HD 147888, 324
 HD 149757, 348
 HD 163296, 499
 HD 183143, 322, 349–352, 594
 HD 206267, 324
 HD 210839, 128
 Hen 2-113, 586
 Her 36, 355, 356
 HH 7-11, 374
 HH 12, 374
 HH 321, 16
 HMM1, 404
 Horsehead nebula, 438, 523, 530, 531, 620
- IC 59/IC63, 620
 IC 1805, 387
 IC 5146, 435
 IM Lup, 499
 IRAS 03260+3111, 586
 IRAS 05110-6616, 571
 IRAS 08576-4334, 94
 IRAS 13416-6243, 571
 IRAS 15384-5348, 586
 IRAS 16293-2422, 404, 463, 464, 473, 506,
 540, 541
 IRAS 17047-5650, 586
 IRAS 18317-0757, 586
 IRAS 18416-0420, 586
 IRAS 21282+5050, 586
 IRAS 22272+5435, 591
 IRAS 23133+6050, 519, 571
 IRC +10216, 571, 605, 606
 IRS 43, 421

- L134N, 398, 399, 404, 432, 435
 L183, *see* L134N
 L1157 outflow, 538–541
 L1489, 432, 433, 460
 L1489 IRS, 423
 L1517, 459, 460
 L1544, 404, 437, 458
 L16293E, 404
 L1630, 620
 Large Magellanic Cloud (LMC), 91
 Lupus IV, 435, 500
- M42, 388, 570
 M51, 12, 14, 570
- NGC 1333, 373, 374
 NGC 2023, 90, 91, 515–518, 573, 574, 598, 620
 NGC 2071 IRS 3, 549
 NGC 7023, 519, 520, 570, 575, 586, 589, 593, 595,
 598, 616
 NGC 7027, 94, 569, 571, 572, 586
- OMC1, 461, 519, 536
 OMC2-FIR 4, 468
 Ophiuchus Molecular Cloud, 500
 Orion Bar, 519–524, 530, 531, 569, 570, 598, 620
 Orion Belt stars, 388
 Orion BN/KL, 461–470, 536, 537, 551
 Orion Compact Ridge, 461–470, 474
 Orion Eridanus Superbubble, 388, 519
 Orion Extended Ridge, 461–464
 Orion Hot Core, 461–464, 541
 Orion Molecular cloud B, 388
 Orion Molecular Cloud Core 1, *see* OMC 1
 Orion Plateau, 536
 Orion Source I, 536
 Orion Veil nebula, 519, 524, 620
- Perseus Molecular Cloud, 373, 374, 532, 599
- RCW 120, 387
 Red Rectangle, 8258, 349, 571, 579, 586, 590
 Reipurth 50, 93, 124, 421
- RW Aur, 501
 RNO 90, 423, 504
- S106, 519, 586
 S140 IRS 1, 423
 Sgr B2 (M), 322
 Sgr B2 (N), 322
 Sk-67 166, 91
 SVS 4-10, 423
- Taurus Molecular Cloud, 435, 457, 500
 TC1, 594, 604
 TMC 1, 351, 352, 398, 399, 404, 432,
 464, 505
 TPSC 78, 421, 423
 Trapezium stars, 388, 570
 TU Tau, 604
 TW Hya, 492, 499, 501, 502, 504
 Ty Cra, 572, 586
- V 4046 Sgr, 499
- W3, 387
 W3 (OH), 550, 551
 W3 IRS 5, 123
 W4, 387
 W33A, 369, 419, 424
 W43, 387
 W49N, 338
 W51, 338
- γ Ara, 620
 ζ Oph, 322, 323, 325, 335, 337, 342, 346,
 349, 412, 620
 ζ Per, 322, 342, 345, 620
 θ^1 Ori C, 388, 519
 λ Ori, 387
 ξ Per, 388
 θ Per, 620
 ρ Oph molecular cloud, 432, 437, 458
 σ Ori, 388, 531
 σ Sco, 349
 9 Sgr, 355

Index of Chemical Compounds

Compound	Chemical Formula	Page
acenaphthene	$C_{12}H_{10}$	302
acetaldehyde	CH_3CHO	31, 34, 227, 399, 400, 464, 523, 540
acetic acid	CH_3COOH	31, 35, 464, 471–478, 540
acetone	CH_3COCH_3	31, 34, 464
acetonitrile, see methyl cyanide		
acetylene (ethyne)	C_2H_2	18, 31, 32, 71, 76, 165, 174, 177, 235, 305, 369, 403, 464, 489, 490, 491, 502, 504, 597, 606–609
acetylene cation	$C_2H_2^+$	190, 330, 403, 526
alamine	$NH_2CH_3CHCOOH$	36
amino acetonitrile	NH_2CH_2CN	7
amino radical	NH_2	227, 235, 322, 333–335, 399, 414
amino radical cation	NH_2^+	334
ammonia	NH_3	7–9, 27, 30, 36, 71–73, 165, 174, 177, 179, 201, 223, 227, 235, 238, 239, 322, 334, 335, 369, 371–375, 378, 399, 401, 414, 424, 428, 430, 432, 434, 461, 471, 478, 490, 491, 508
ammonia cation	NH_3^+	333, 334, 401
aniline	$C_6H_5NH_2$	36
anthanthracene	$C_{22}H_{12}$	260
anthracene	$C_{14}H_{10}$	260, 262, 297, 302, 304, 613
argonium	ArH^+	322, 343
azulene	$C_{10}H_8$	33, 302
benzene	C_6H_6	26, 27, 33, 60, 243, 261, 263, 271–272, 304, 308, 605–607, 609
benzoic acid	C_6H_5COOH	35
benzonitrile	C_6H_5CN	399
Buckmunsterfullerene	C_{60}	33, 177, 258, 293, 301, 308–312, 593, 594, 598, 604, 610, 611
Buckmunsterfullerene, cation	C_{60}^+	258, 293, 322, 350–354, 594, 598
butadiynyl cation	C_4H^+	609
butadiynyl radical	C_4H	399, 523, 609
1-buten-3-ynyl	$n-C_4H_3$	607

Compound	Chemical Formula	Page
C ₂₄ -fullerene	C ₂₄	308
C ₂₈ -fullerene	C ₂₈	308
C ₃₂ -fullerene	C ₃₂	308
C ₃₆ -fullerene	C ₃₆	308
C ₅₀ -fullerene	C ₅₀	308
C ₅₈ -fullerene	C ₅₈	308
C ₇₀ -fullerene	C ₇₀	33, 308
carbon dioxide	CO ₂	7–9, 18, 27, 30, 60, 71, 73, 174, 180, 223, 237, 413, 424, 428, 430, 435, 464, 489, 502, 504
carbon disulfide	CS ₂	240
carbon monoxide	CO	7, 18, 60, 72, 73, 91–94, 165, 174, 177, 178, 193, 223, 227, 232–234, 237, 238, 243, 304, 322, 325, 330, 331, 333, 367, 369, 373, 375, 395, 388, 424, 426–428, 430, 432, 433, 435, 460, 464, 489, 492, 500, 502, 521, 523, 532, 535–537, 539, 540
carbon monoxide cation	CO ⁺	178, 197, 330, 523, 527
carbon sulfide	CS	72, 235, 322, 336, 369, 379, 399, 413, 414, 432, 433, 459–461, 464, 522, 523, 540
carbon sulfide cation	CS ⁺	336
carbonic acid	H ₂ CO ₃	30
carbonyl sulfide	OCS	237, 399, 424, 464, 540
chrysene	C ₁₈ H ₁₂	260, 263, 579, 580
circumcircumcircumcoronene	C ₁₅₀ H ₃₀	582
circumcircumcoronene	C ₉₆ H ₂₄	264, 278, 281–283, 299, 582, 593, 615, 616
circumcoronene	C ₅₄ H ₁₈	177, 260, 264, 269, 271, 273, 278, 282, 283, 292, 293, 299, 301, 308, 309, 356, 583, 593, 615, 616
circumvalene	C ₆₆ H ₂₀	273, 299
circumpyrene	C ₄₂ H ₁₆	273
corannulene	C ₂₀ H ₁₀	604
coronene	C ₂₄ H ₁₂	177, 259, 260, 264, 268, 271, 273, 278, 282, 283, 293, 296, 299, 300, 302, 304, 306, 308, 594, 607, 613, 617
cyanate anion	OCN ⁻	424
cyano acetylene	HC ₃ N	31, 116, 118, 119, 165, 174, 399, 403, 433, 464, 523, 540, 609
cyano diacetylene	HC ₅ N	322, 351, 399, 540
cyano ethynyl methylene	HC ₄ N	399
cyano ethynyl radical	C ₃ N	399
cyano methyl radical	CH ₂ CN	399
cyano propyne	CH ₃ C ₂ CN	399
cyano radical	CN	165, 183, 227, 235, 318, 319, 322, 325, 334, 336, 399, 403, 413, 414, 522, 523
cyano tetraacetylene	HC ₉ N	399
cyano triacetylene	HC ₇ N	399
cyanobutadiynyl radical	C ₅ N	399

Compound	Chemical Formula	Page
cyclic propynylidyne	c-C ₃ H	322, 399, 403, 523, 526
cyclohexane	C ₆ H ₁₂	26
cyclopentadiene anion	C ₅ H ₆ ⁻	261
cyclopentadienyl	c-C ₅ H ₅	607
cyclopropenyl cation	C ₃ H ₃ ⁺	609
cyclopropenylidene	c-C ₃ H ₂	399, 526, 531
d1-hydroxymethyl radical	CHDOH	233
d2-hydroxymethyl radical	CD ₂ OH	233
d2-methanol	CHD ₂ OH	233
deuterated acetic acid	CH ₂ DCOOH & CH ₃ COOD	470
deuterated acetylene cation	C ₂ HD ⁺	406
deuterated ammonia	NH ₂ D	404, 428
deuterated butadiynyl	C ₄ D	404
deuterated cyano acetylene	DC ₃ N	404
deuterated cyano diacetylene	DC ₅ N	404
deuterated ethynyl	C ₂ D	404
deuterated formaldehyde	HDCO	404, 429, 469, 538, 540
deuterated formyl cation	DCO ⁺	404, 409, 428, 523
deuterated formyl radical	DCO	233, 429
deuterated hydrogen sulfide	HDS	404, 470, 540
deuterated imidogen	ND	404
deuterated methanol (d1-methanol)	CH ₂ DOH	233, 429, 469, 470, 540
deuterated methoxy radical	CHD ₂ O	429
deuterated methyl cyanide	CH ₂ DCN	470
deuterated methyl formate	DCOOCH ₃ & HCOOCH ₂ D	470
deuterated methyl radical cation	CH ₂ D ⁺	406
deuterated propenylidene	c-C ₃ HD	404
deuterated propyne	CH ₂ DC ₂ H	404
deuterated thioformaldehyde	HDCS	404
deuterated water	HDO	469, 470, 530
deuterium cyanide	DCN	404
deuterium hydride	HD	177, 223, 322, 344–346, 405, 501
deuterium isocyanide	DNC	404
deuterated deuterium	D ₃ ⁺	405, 434
deuterated dinitrogen	N ₂ D ⁺	404
deuterated molecular hydrogen	H ₂ D ⁺	405, 406, 410, 434
diacetylene	C ₄ H ₂	399, 403, 605, 609
diacetylene cation	C ₄ H ₂ ⁺	403, 609
dicarbon	C ₂	165, 322, 323, 324, 330, 342, 343, 399
dicarbon monosulfide radical	C ₂ S	399, 414, 433, 464, 530
dicarbon monoxide	C ₂ O	399
diimide	N ₂ H ₂	227, 235, 427
dimethyl ether	CH ₃ OCH ₃	18, 26, 31, 174, 177, 461, 462, 464, 471–478, 540
dinitrogen monohydride	N ₂ H	227
doubly deuterated acetic acid	CHD ₂ COOH	470
doubly deuterated ammonia	ND ₂ H	404, 428
doubly deuterated formaldehyde	D ₂ CO	404, 429, 430, 469, 470

Compound	Chemical Formula	Page
doubly deuterated hydrogen sulfide	D ₂ S	404
doubly deuterated methanol (d ₂ -methanol)	CHD ₂ OH	233, 429, 430, 469, 470
doubly deuterated molecular hydrogen	D ₂	177, 223
doubly deuterated propenylidene	c-C ₃ D ₂	404
doubly deuterated water	D ₂ O	469, 470
ethane	C ₂ H ₆	31, 60
ethanol	CH ₃ CH ₂ OH	26, 31, 34, 174, 177, 239, 413, 461, 464, 540
ethenone	CH ₂ CO	464
ethyl cyanide	CH ₃ CH ₂ CN	461, 464
ethyl formate	CH ₃ COOCH ₃	464
ethylene	C ₂ H ₄	28, 31, 32, 235, 475
ethylene (ethene) cation	C ₂ H ₄ ⁺	190
ethylene glycol	(CH ₂ OH) ₂	461, 462, 464
ethynyl cation	C ₂ H ⁺	330, 526
ethynyl radical	C ₂ H	83, 165, 322, 330, 341, 399, 403, 414, 523, 526, 607
fluoranthene	C ₁₆ H ₁₀	302
fluorine	F ₂	27
fluoromethylidyne cation	CF ⁺	322, 337, 523
formaldehyde	H ₂ CO	7, 8, 17, 31, 34, 35, 65, 71–73, 86, 95, 165, 174, 177, 223, 227, 232–234, 238, 239, 322, 374, 375, 379, 399, 400, 413, 424, 427, 430, 432, 433, 461, 464, 471–478, 492, 506, 508, 523, 530, 540
formamide	HCONH ₂	227, 239, 464, 472, 507
formic acid	HCOOH	30, 35, 223, 227, 239, 399, 400, 424, 461, 464, 471–478, 506, 523, 540
formyl cation	HCO ⁺	72, 178, 197, 322, 330, 338, 340, 341, 399, 400, 409, 413, 428, 432, 433, 464, 490, 521–523, 527, 540
formyl radical	HCO	165, 232–234, 237, 322, 399, 427, 472, 473, 523
formyloxyl	HCOO	227
glycine	NH ₂ CH ₂ COOH	7, 8, 31, 36, 508, 509
glycol aldehyde	HOCH ₂ CHO	464, 471–478, 540
hexabenzocoronene	C ₄₂ H ₁₈	260, 299
1, 3, 5-hexatrienyl anion	C ₆ H ⁻	415
1, 3, 5-hexatrienyl radical	C ₆ H	399, 415
hydrazine	N ₂ H ₄	235
hydrocarboxyl radical	HOCO	427
hydrocarboxyl radical cation	HOCO ⁺	540
hydrogen chloride	HCl	30, 35, 322, 338
hydrogen chloride cation	HCl ⁺	322, 338

Compound	Chemical Formula	Page
hydrogen cyanide	HCN	7, 8, 31, 36, 72, 165, 174, 177, 227, 235, 238, 304, 322, 334, 369, 379, 390, 401, 413, 414, 433, 461, 464, 490, 491, 502–505, 508, 523, 540, 584, 606
hydrogen cyanide-d1	DCN	523, 540
hydrogen fluoride	HF	27, 322, 337, 338, 341
hydrogen isocyanide	HNC	227, 322, 334, 399, 403
hydrogen peroxide	H ₂ O ₂	227, 233, 234, 399, 425, 437, 477
hydrogen sulfide	H ₂ S	235, 322, 336, 399, 427, 535, 540
hydroperoxy radical	HO ₂	227, 228, 234, 425, 437, 477
hydroxyl cation	OH ⁺	165, 178, 197, 322, 330, 331, 344, 345, 347, 523
hydroxyl radical	OH	67–69, 165, 174, 178, 183, 184, 197, 201, 227, 234, 235, 238, 322, 331, 339–341, 344, 345, 399, 400, 502, 523, 526, 527, 535–537, 539
hydroxylamine	NH ₂ OH	540
hydroxymethyl radical	CH ₂ OH	233, 236, 477
hydroxymethylidyne cation	HOC ⁺	178, 322, 523, 527
imidogen	NH	227, 322, 333–335, 399
imidogen cation	NH ⁺	202, 322
iso cyano acetylene (iminopropadienyldiene)	HNC ₃	399
isocyanato radical	NCO	227, 235
isocyanic acid	HNCO	227, 235, 464, 472, 523, 540, 541
ketene	H ₂ C ₂ O	399, 532
mercapto cation	SH ⁺	322, 336, 339–341, 523–525
mercapto radical	SH	322, 336, 337
methane	CH ₄	7–9, 18, 26, 27, 32, 65, 76, 174, 177, 193, 223, 227, 235, 239, 331, 369, 400, 403, 413, 424, 428, 430, 489, 490, 491
methanimine	CH ₂ NH	540
methanol	CH ₃ OH	17, 18, 34, 73, 174, 177, 223, 227, 232–236, 238, 239, 305, 322, 369, 374, 413, 424, 427, 430, 433, 435, 460, 461, 464, 466, 468–481, 492, 506, 523, 530
methoxy radical	CH ₃ O	227, 233, 235, 236, 477
methyl acetate	CH ₃ COOCH ₃	35
methyl amine	CH ₃ NH ₂	31, 36, 508
methyl cation	CH ₃ ⁺	165, 190, 197, 322, 330, 331, 336, 400, 526
methyl cyanide (acetonitrile)	CH ₃ CN	31, 36, 177, 305, 374, 399, 461, 464, 466, 540
methyl formate	HCOOCH ₃	18, 31, 35, 461, 462, 471–478, 507, 540
methyl isocyanate	CH ₃ NCO	464
methyl mercaptan	CH ₃ SH	235
methyl peroxide	CH ₃ OOH	239
methyl radical	CH ₃	165, 227, 235

Compound	Chemical Formula	Page
methylene	CH ₂	165, 184, 197, 227, 235, 322, 330, 336, 526, 607
methylene cation	CH ₂ ⁺	189, 190, 197, 330, 331, 336, 526
methylene glycol	CH ₂ (OH) ₂	239
methylidyne	CH	165, 184, 190, 197, 227, 235, 318, 319, 322, 324, 330, 332, 336, 338–340, 399, 523, 610
methylidyne cation	CH ⁺	165, 184–186, 190, 197, 201, 318, 319, 322, 330, 332, 336, 338–340, 403, 523–525
molecular hydrogen	H ₂	25, 27, 28, 70, 72, 73, 88–91, 124–128, 143–145, 149, 150, 168–172, 177, 193, 197, 216, 217, 223, 227, 235, 236, 238, 322, 399, 532, 535, 538, 539
molecular hydrogen cation	H ₂ ⁺	178
molecular nitrogen	N ₂	177, 179, 180, 193, 223, 227, 238, 243, 322, 334, 399, 428, 490, 491
molecular oxygen	O ₂	28, 71, 165, 174, 177, 178, 179, 184, 193, 223, 227, 234, 236, 239, 395, 399, 425, 426, 438, 477
naphthyl	C ₁₀ H ₇	609
naphthalene	C ₁₀ H ₈	33, 260, 262, 299, 302, 306, 308, 596, 607
nitric oxide	NO	227, 327, 399, 540
nitrogen dioxide	NO ₂	237
nitrosyl hydride	HNO	227, 235
octatetraenyl radical	C ₈ H	399
ovalene	C ₃₂ H ₁₄	260, 273, 292, 293, 299
ozone	O ₃	223, 426, 477
pentadiyne	CH ₃ C ₄ H	399
pentadiynylidyne radical	C ₄ H	399, 526
perylene	C ₂₀ H ₁₂	260
phenanthrene	C ₁₄ H ₁₀	260, 302
phenol (carbolic acid)	C ₆ H ₅ OH	34
phenyl	C ₆ H ₅	306, 607
phenyl cation	C ₆ H ₅ ⁺	609
2-phenyl ethenylum	C ₈ H ₇ ⁺	609
phosphene	PH ₃	540
phosphorus mononitride	PN	540
phosphorus monoxide	PO	540
propane	C ₃ H ₈	32
propane nitrile, see ethyl cyanide		
propargyl radical	C ₃ H ₃	606
propenylidene	C ₃ H ₂	322, 399, 432, 523, 526
propenylidene (linear)	C ₃ H ₂	399, 526, 531
propyne	CH ₃ C ₂ H	399
propynylidene cation	C ₃ H ⁺	523, 526, 609
propynylidene	C ₃ H	399
protonated acetylene	C ₂ H ₃ ⁺	330, 403, 609

Compound	Chemical Formula	Page
protonated ammonia	NH_4^+	333, 334
protonated carbon sulfide	HCS^+	336
protonated cyano acetylene	HC_3NH^+	399, 403
protonated deuterium	HD_2^+	404, 405, 434
protonated diacetylene	C_4H_3^+	403, 609
protonated hydrogen chloride	H_2Cl^+	322, 338, 523
protonated hydrogen cyanide	HCNH^+	399, 403, 475
protonated hydrogen sulfide	H_3S^+	336
protonated methane	CH_5^+	190, 331
protonated methanol	CH_3OH_2^+	190, 474, 475
protonated methylcyanide	CH_3CNH^+	475
protonated molecular hydrogen	H_3^+	178, 197, 322, 342, 343, 367, 400, 403, 407–409, 434, 459
protonated molecular nitrogen	N_2H^+	334, 399, 400, 401, 414, 432, 434, 450, 460, 490, 502, 540
protonated water	H_3O^+	178, 197, 322, 330, 331, 344
pyranthrene	$\text{C}_{30}\text{H}_{16}$	260
pyrene	$\text{C}_{16}\text{H}_{10}$	177, 260, 273, 293, 302, 579, 580, 582, 583, 607, 613, 617
silicon monosulfide	SiS	540, 606
silicon monoxide	SiO	461, 532, 535, 538, 540
sulfur dioxide	SO_2	237, 369, 399, 464, 468, 535, 540
sulfur monoxide	SO	237, 322, 399, 433, 461, 464, 532, 535, 540
sulfur monoxide cation	SO^+	523, 527, 540
tetrabenzocircumperylene (diamondPAH)	$\text{C}_{66}\text{H}_{26}$	613
tetracene	$\text{C}_{18}\text{H}_{12}$	263, 287
thioformaldehyde	H_2CS	235, 399, 464, 523, 540
thioformyl cation	HCS^+	399, 464, 530
triacetylene	C_6H_2	605
tricarbon	C_3	322
tricarbon cation	C_3^+	526
tricarbon monosulfide radical	C_3S	399, 414, 464
tricarbon monoxide	C_3O	399
triphenylene	$\text{C}_{18}\text{H}_{12}$	263
triply deuterated ammonia	ND_3	428
triply deuterated methanol (d3-methanol)	CD_3OH	429, 430, 469, 470
tropylium cation	C_7H_7^+	261
urea	$\text{CO}(\text{NH}_2)_2$	7
vinyl acetylene	C_4H_4	306, 609
vinyl cyanide	CH_2CHCN	464, 475

Index of Chemical Compounds

647

Compound	Chemical Formula	Page
water	H ₂ O	8, 27, 30, 60, 65, 66, 71, 73, 165, 174, 175, 177–179, 184, 190, 193, 197, 223, 227, 234, 235, 238, 239, 243, 322, 330, 331, 338, 341, 369, 395, 399, 400, 424–426, 430, 435, 438, 461, 464, 469–481, 502–505, 523, 535–537, 539, 540
water cation	H ₂ O ⁺	178, 197, 322, 330, 331, 344

Chemical Formula	Compound	Page
(CH ₂ OH) ₂	ethylene glycol	461, 462, 464
ArH ⁺	argonium	322, 343
c-C ₃ D ₂	doubly deuterated propenylidene	404
c-C ₃ H	cyclic propynylidyne	322, 399, 403, 523, 526
c-C ₃ H ₂	cyclopropenylidene	399, 526, 531
c-C ₃ HD	deuterated propenylidene	404
c-C ₅ H ₅	cyclopentadienyl	607
C ₁₀ H ₇	naphthyl	609
C ₁₀ H ₈	azulene	33, 302
C ₁₀ H ₈	naphthalene	33, 260, 262, 299, 302, 306, 308, 596, 607
C ₁₂ H ₁₀	acenaphthene	302
C ₁₄ H ₁₀	anthracene	260, 262, 297, 302, 304, 613
C ₁₄ H ₁₀	phenanthrene	260, 302
C ₁₅₀ H ₃₀	circumcircumcircumcoronene	582
C ₁₆ H ₁₀	fluoranthene	302
C ₁₆ H ₁₀	pyrene	177, 260, 273, 293, 302, 579, 580, 582, 583, 607, 613, 617
C ₁₈ H ₁₂	chrysene	260, 263, 579, 580
C ₁₈ H ₁₂	tetracene	263, 287
C ₁₈ H ₁₂	triphenylene	263
C ₂	dicarbon	165, 322, 323, 324, 330, 342, 343, 399
C ₂₀ H ₁₀	corannulene	604
C ₂₀ H ₁₂	perylene	260
C ₂₂ H ₁₂	anthanthracene	260
C ₂₄	C ₂₄ -fullerene	308
C ₂₄ H ₁₂	coronene	177, 259, 260, 264, 268, 271, 273, 278, 282, 283, 293, 296, 299, 300, 302, 304, 306, 308, 594, 607, 613, 617
C ₂₈	C ₂₈ -fullerene	308
C ₂ D	deuterated ethynyl	404
C ₂ H	ethynyl radical	83, 165, 322, 330, 341, 399, 403, 414, 523, 526, 607
C ₂ H ⁺	ethynyl cation	330, 526
C ₂ H ₂	acetylene (ethyne)	18, 31, 32, 71, 76, 165, 174, 177, 235, 305, 369, 403, 464, 489, 490, 491, 502, 504, 597, 606–609
C ₂ H ₂ ⁺	acetylene cation	190, 330, 403, 526

Chemical Formula	Compound	Page
$C_2H_3^+$	protonated acetylene	330, 403, 609
C_2H_4	ethylene	28, 31, 32, 235, 475
$C_2H_4^+$	ethylene (ethene) cation	190
C_2H_6	ethane	31, 60
C_2HD^+	deuterated acetylene cation	406
C_2O	dicarbon monoxide	399
C_2S	dicarbon monosulfide	399, 414, 433, 464, 530
	radical	
C_3	tricarbon	322
C_3^+	tricarbon cation	526
$C_{30}H_{16}$	pyranthrene	260
C_{32}	C_{32} -fullerene	308
$C_{32}H_{14}$	ovalene	260, 273, 292, 293, 299
C_{36}	C_{36} -fullerene	308
C_3H	propynylidene	399
C_3H^+	propynylidene cation	523, 526, 609
C_3H_2	propenylidene	322, 399, 432, 523, 526
C_3H_2	propenylidene (linear)	399, 526, 531
C_3H_3	propargyl radical	606
$C_3H_3^+$	cyclopropenyl cation	609
C_3H_8	propane	32
C_3N	cyano ethynyl radical	399
C_3O	tricarbon monoxide	399
C_3S	tricarbon monosulfide	399, 414, 464
	radical	
$C_{42}H_{16}$	circumphyrene	273
$C_{42}H_{18}$	hexabenzocoronene	260, 299
C_4D	deuterated butadiynyl	404
C_4H	butadiynyl radical	399, 523, 609
C_4H	pentadiynylidyne radical	399, 526
C_4H^+	butadiynyl cation	609
C_4H_2	diacetylene	399, 403, 605, 609
$C_4H_2^+$	diacetylene cation	403, 609
$C_4H_3^+$	protonated diacetylene	403, 609
C_4H_4	vinyl acetylene	306, 609
C_{50}	C_{50} -fullerene	308
$C_{54}H_{18}$	circumcoronene	177, 260, 264, 269, 271, 273, 278, 282, 283, 292, 293, 299, 301, 308, 309, 356, 583, 593, 615, 616
C_{58}	C_{58} -fullerene	308
$C_5H_6^-$	cyclopentadiene anion	261
C_5N	cyanobutadiynyl radical	399
C_{60}	Buckminsterfullerene	33, 177, 258, 293, 301, 308–312, 593, 594, 598, 604, 610, 611
C_{60}^+	Buckminsterfullerene, cation	258, 293, 322, 350–354, 594, 598
$C_{66}H_{20}$	circumovalene	273, 299
$C_{66}H_{26}$	tetrabenzocircumperylene (diamondPAH)	613
C_6H	1, 3, 5-hexatriynyl radical	399, 415
C_6H^-	1, 3, 5-hexatriynyl anion	415

Chemical Formula	Compound	Page
C ₆ H ₁₂	cyclohexane	26
C ₆ H ₂	triacetylene	605
C ₆ H ₅	phenyl	306, 607
C ₆ H ₅ ⁺	phenyl cation	609
C ₆ H ₅ CN	benzonitrile	399
C ₆ H ₅ COOH	benzoic acid	35
C ₆ H ₅ NH ₂	aniline	36
C ₆ H ₅ OH	phenol (carbolic acid)	34
C ₆ H ₆	benzene	26, 27, 33, 60, 243, 261, 263, 271–272, 304, 308, 605–607, 609
C ₇₀	C ₇₀ -fullerene	33, 308
C ₇ H ₇ ⁺	tropylium cation	261
C ₈ H	octatetraenyl radical	399
C ₈ H ₇ ⁺	2-phenyl ethenylum	609
C ₉₆ H ₂₄	circumcircumcoronene	264, 278, 281–283, 299, 582, 593, 615, 616
CD ₂ OH	d2-hydroxymethyl radical	233
CD ₃ OH	triply deuterated methanol (d3-methanol)	429, 430, 469, 470
CF ⁺	fluoromethylidyne cation	322, 337, 523
CH	methylidyne	165, 184, 190, 197, 227, 235, 318, 319, 322, 324, 330, 332, 336, 338–340, 399, 523, 610
CH ⁺	methylidyne cation	165, 184–186, 190, 197, 201, 318, 319, 322, 330, 332, 336, 338–340, 403, 523–525
CH ₂	methylene	165, 184, 197, 227, 235, 322, 330, 336, 526, 607
CH ₂ (OH) ₂	methylene glycol	239
CH ₂ ⁺	methylene cation	189, 190, 197, 330, 331, 336, 526
CH ₂ CHCN	vinyl cyanide	464, 475
CH ₂ CN	cyano methyl radical	399
CH ₂ CO	ethenone	464
CH ₂ D ⁺	deuterated methyl radical cation	406
CH ₂ DC ₂ H	deuterated propyne	404
CH ₂ DCN	deuterated methyl cyanide	470
CH ₂ DCOOH & CH ₃ COOD	deuterated acetic acid	470
CH ₂ DOH	deuterated methanol (d1-methanol)	233, 429, 469, 470, 540
CH ₂ NH	methanimine	540
CH ₂ OH	hydroxymethyl radical	233, 236, 477
CH ₃	methyl radical	165, 227, 235
CH ₃ ⁺	methyl cation	165, 190, 197, 322, 330, 331, 336, 400, 526
CH ₃ C ₂ CN	cyano propyne	399
CH ₃ C ₂ H	propyne	399
CH ₃ C ₄ H	pentadiyne	399
CH ₃ CH ₂ CN	ethyl cyanide (propane nitrile)	461, 464

Chemical Formula	Compound	Page
CH ₃ CH ₂ OH	ethanol	26, 31, 34, 174, 177, 239, 413, 461, 464, 540
CH ₃ CHO	acetaldehyde	31, 34, 227, 399, 400, 464, 523, 540
CH ₃ CN	methyl cyanide (acetonitrile)	31, 36, 177, 305, 374, 399, 461, 464, 466, 540
CH ₃ CNH ⁺	protonated methylcyanide	475
CH ₃ COCH ₃	acetone	31, 34, 464
CH ₃ COOCH ₃	ethyl formate	464
CH ₃ COOCH ₃	methyl acetate	35
CH ₃ COOH	acetic acid	31, 35, 464, 471–478, 540
CH ₃ NCO	methyl isocyanate	464
CH ₃ NH ₂	methyl amine	31, 36, 508
CH ₃ O	methoxy radical	227, 233, 235, 236, 477
CH ₃ OCH ₃	dimethyl ether	18, 26, 31, 174, 177, 461, 462, 464, 471–478, 540
CH ₃ OH	methanol	17, 18, 34, 73, 174, 177, 223, 227, 232–236, 238, 239, 305, 322, 369, 374, 413, 424, 427, 430, 433, 435, 460, 461, 464, 466, 468–481, 492, 506, 523, 530
CH ₃ OH ₂ ⁺	protonated methanol	190, 474, 475
CH ₃ OOH	methyl peroxide	239
CH ₃ SH	methyl mercaptan	235
CH ₄	methane	7–9, 18, 26, 27, 32, 65, 76, 174, 177, 193, 223, 227, 235, 239, 331, 369, 400, 403, 413, 424, 428, 430, 489, 490, 491
CH ₅ ⁺	protonated methane	190, 331
CHD ₂ COOH	doubly deuterated acetic acid	470
CHD ₂ O	deuterated methoxy radical	429
CHD ₂ OH	d2-methanol	233
CHD ₂ OH	doubly deuterated methanol (d2-methanol)	233, 429, 430, 469, 470
CHDOH	d1-hydroxymethyl radical	233
CN	cyano radical	165, 183, 227, 235, 318, 319, 322, 325, 334, 336, 399, 403, 413, 414, 522, 523, 178, 193, 223, 227, 232–234, 237, 238, 243, 304, 322, 325, 330, 331, 333, 367, 369, 373, 375, 388, 395, 424, 426–428, 430, 432, 433, 435, 460, 464, 489, 492, 500, 502, 521, 523, 532, 535–537, 539, 540
CO	carbon monoxide	7, 18, 60, 72, 73, 91–94, 165, 174, 177, 178, 193, 223, 227, 232–234, 237, 238, 243, 304, 322, 325, 330, 331, 333, 367, 369, 373, 375, 388, 395, 424, 426–428, 430, 432, 433, 435, 460, 464, 489, 492, 500, 502, 521, 523, 532, 535–537, 539, 540
CO(NH ₂) ₂	urea	7
CO ⁺	carbon monoxide cation	178, 197, 330, 523, 527
CO ₂	carbon dioxide	7–9, 18, 27, 30, 60, 71, 73, 174, 180, 223, 237, 413, 424, 428, 430, 435, 464, 489, 502, 504
CS	carbon sulfide	72, 235, 322, 336, 369, 379, 399, 413, 414, 432, 433, 459–461, 464, 522, 523, 540

Index of Chemical Compounds

651

Chemical Formula	Compound	Page
CS ⁺	carbon sulfide cation	336
CS ₂	carbon disulfide	240
D ₂	doubly deuterated molecular hydrogen	177, 223
D ₂ CO	doubly deuterated formaldehyde	404, 429, 430, 469, 470
D ₂ O	doubly deuterated water	469, 470
D ₂ S	doubly deuterated hydrogen sulfide	404
D ₃ ⁺	deuterated deuterium	405, 434
DC ₃ N	deuterated cyano acetylene	404
DC ₅ N	deuterated cyano diacetylene	404
DCN	deuterium cyanide	404
DCN	hydrogen cyanide-d1	523, 540
DCO	deuterated formyl radical	233, 429
DCO ⁺	deuterated formyl cation	404, 409, 428, 523
DCOOCH ₃ & HCOOCH ₂ D	deuterated methyl formate	470
DNC	deuterium isocyanide	404
F ₂	fluorine	27
H ₂	molecular hydrogen	25, 27, 28, 70, 72, 73, 88–91, 124–128, 193, 143–145, 149, 150, 168–172, 177, 197, 216, 217, 223, 227, 235, 236, 238, 322, 399, 532, 535, 538, 539
H ₂ ⁺	molecular hydrogen cation	178
H ₂ C ₂ O	ketene	399, 532
H ₂ Cl ⁺	protonated hydrogen chloride	322, 338, 523
H ₂ CO	formaldehyde	7, 8, 17, 31, 34, 35, 65, 71–73, 86, 95, 165, 174, 177, 223, 227, 232–234, 238, 239, 322, 374, 375, 379, 399, 400, 413, 424, 427, 430, 432, 433, 461, 464, 471–478, 492, 506, 508, 523, 530, 540
H ₂ CO ₃	carbonic acid	30
H ₂ CS	thioformaldehyde	235, 399, 464, 523, 540
H ₂ D ⁺	deuterated molecular hydrogen	405, 406, 410, 434
H ₂ O	water	8, 27, 30, 60, 65, 66, 71, 73, 165, 174, 175, 177–179, 184, 190, 193, 197, 223, 227, 234, 235, 238, 239, 243, 322, 330, 331, 338, 341, 369, 395, 399, 400, 424–426, 430, 435, 438, 461, 464, 469–481, 502–505, 523, 535–537, 539, 540
H ₂ O ⁺	water cation	178, 197, 322, 330, 331, 344
H ₂ O ₂	hydrogen peroxide	227, 233, 234, 399, 425, 437, 477
H ₂ S	hydrogen sulfide	235, 322, 336, 399, 427, 535, 540

Chemical Formula	Compound	Page
H ₃ ⁺	protonated molecular hydrogen	178, 197, 322, 342, 343, 367, 400, 403, 407–409, 434, 459
H ₃ O ⁺	protonated water	178, 197, 322, 330, 331, 344
H ₃ S ⁺	protonated hydrogen sulfide	336
HC ₃ N	cyano acetylene	31, 116, 118, 119, 165, 174, 399, 403, 433, 464, 523, 540, 609
HC ₃ NH ⁺	protonated cyano acetylene	399, 403
HC ₄ N	cyano ethynyl methylene	399
HC ₅ N	cyano diacetylene	322, 351, 399, 540
HC ₇ N	cyano triacetylene	399
HC ₉ N	cyano tetraacetylene	399
HCl	hydrogen chloride	30, 35, 322, 338
HCl ⁺	hydrogen chloride cation	322, 338
HCN	hydrogen cyanide	7, 8, 31, 36, 72, 165, 174, 177, 227, 235, 238, 304, 322, 334, 369, 379, 390, 401, 413, 414, 433, 461, 464, 490, 491, 502–505, 508, 523, 540, 584, 606
HCNH ⁺	protonated hydrogen cyanide	399, 403, 475
HCO	formyl radical	165, 232–234, 237, 322, 399, 427, 472, 473, 523
HCO ⁺	formyl cation	72, 178, 197, 322, 330, 338, 340, 341, 399, 400, 409, 413, 428, 432, 433, 464, 490, 521–523, 527, 540
HCONH ₂	formamide	227, 239, 464, 472, 507
HCOO	formyloxyl	227
HCOOCH ₃	methyl formate	18, 31, 35, 461, 462, 471–478, 507, 540
HCOOH	formic acid	30, 35, 223, 227, 239, 399, 400, 424, 461, 464, 471–478, 506, 523, 540
HCS ⁺	protonated carbon sulfide	336
HCS ⁺	thioformyl cation	399, 464, 530
HD	deuterium hydride	177, 223, 322, 344–346, 405, 501
HD ₂ ⁺	protonated deuterium	404, 405, 434
HDCO	deuterated formaldehyde	404, 429, 469, 538, 540
HDCS	deuterated thioformaldehyde	404
HDO	deuterated water	469, 470, 530
HDS	deuterated hydrogen sulfide	404, 470, 540
HF	hydrogen fluoride	27, 322, 337, 338, 341
HNC	hydrogen isocyanide	227, 322, 334, 399, 403
HNC ₃	iso cyano acetylene (iminipropadienylidene)	399
HNCO	isocyanic acid	227, 235, 464, 472, 523, 540, 541
HNO	nitrosyl hydride	227, 235
HO ₂	hydroperoxy radical	227, 228, 234, 425, 437, 477
HOC ⁺	hydroxymethylidyne cation	178, 322, 523, 527
HOCH ₂ CHO	glycol aldehyde	464, 471–478, 540
HOCO	hydrocarboxyl radical	427
HOCO ⁺	hydrocarboxyl radical cation	540

Chemical Formula	Compound	Page
n-C ₄ H ₃	1-buten-3-ynyl	607
N ₂	molecular nitrogen	177, 179, 180, 193, 223, 227, 238, 243, 322, 334, 399, 428, 490, 491
N ₂ D ⁺	deuterated dinitrogen	404
N ₂ H	dinitrogen monohydride	227
N ₂ H ⁺	protonated molecular nitrogen	334, 399, 400, 401, 414, 432, 434, 450, 460, 490, 502, 540
N ₂ H ₂	diimide	227, 235, 427
N ₂ H ₄	hydrazine	235
NCO	isocyanato radical	227, 235
ND	deuterated imidogen	404
ND ₂ H	doubly deuterated ammonia	404, 428
ND ₃	triply deuterated ammonia	428
NH	imidogen	227, 322, 333–335, 399
NH ⁺	imidogen cation	202, 322
NH ₂	amino radical	227, 235, 322, 333–335, 399, 414
NH ₂ ⁺	amino radical cation	334
NH ₂ CH ₂ CN	amino acetonitrile	7
NH ₂ CH ₂ COOH	glycine	7, 8, 31, 36, 508, 509
NH ₂ CH ₃ CHCOOH	alamine	36
NH ₂ D	deuterated ammonia	404, 428
NH ₂ OH	hydroxylamine	540
NH ₃	ammonia	7–9, 27, 30, 36, 71–73, 165, 174, 177, 179, 201, 223, 227, 235, 238, 239, 322, 334, 335, 369, 371–375, 378, 399, 401, 414, 424, 428, 430, 432, 434, 461, 471, 478, 490, 491, 508
NH ₃ ⁺	ammonia cation	333, 334, 401
NH ₄ ⁺	protonated ammonia	333, 334
NO	nitric oxide	227, 327, 399, 540
NO ₂	nitrogen dioxide	237
O ₂	molecular oxygen	28, 71, 165, 174, 177, 178, 179, 184, 193, 223, 227, 234, 236, 239, 395, 399, 425, 426, 438, 477
O ₃	ozone	223, 426, 477
OCN [−]	cyanate anion	424
OCS	carbonyl sulfide	237, 399, 424, 464, 540
OH	hydroxyl radical	67–69, 165, 174, 178, 183, 184, 197, 201, 227, 234, 235, 238, 322, 331, 339–341, 344, 345, 399, 400, 502, 523, 526, 527, 535–537, 539
OH ⁺	hydroxyl cation	165, 178, 197, 322, 330, 331, 344, 345, 347, 523
PH ₃	phosphene	540
PN	phosphorus mononitride	540
PO	phosphorus monoxide	540
SH	mercapto radical	322, 336, 337
SH ⁺	mercapto cation	322, 336, 339–341, 523–525

Chemical Formula	Compound	Page
SiO	silicon monoxide	461, 532, 535, 538, 540
SiS	silicon monosulfide	540, 606
SO	sulfur monoxide	237, 322, 399, 433, 461, 464, 532, 535, 540
SO ⁺	sulfur monoxide cation	523, 527, 540
SO ₂	sulfur dioxide	237, 369, 399, 464, 468, 535, 540