Index

action-angle variables, 59, 60, 166
  generating function, 59
atlas of charts, 5
bead on a rotating circle, 15
Birkhoff–Gustavson perturbation theory, 109, 111, 119, 128, 144, 152, 181
canonical momentum, 8
metrical transformation, 30
  conserved Poisson brackets, 31
  continuous groups, 40
  examples, 32
  explicit time dependence, 39
  generating function, 34
  preservation of Hamilton’s equations, 31
  simple examples, 32
chaos, 108, 115, 130, 131, 135
chaotic moon, 139
chart, 5
configuration space, 2, 5
constraints, 1, 2, 4
degree of freedom, 1, 15, 18
diffeomorphism, 5
diffusion coefficient, 134
dynamical pendulum, 27, 148
electrodynamics
  Hamiltonian formulation, 42
elliptic fixed point, 122
elliptic function, 26
elliptic integral, 15, 26
energy–momentum diagram, 70, 74, 79, 83, 89
energy–momentum map, 158, 160
equations of motion, 178
Euler–Lagrange equations, 7
fast track to action-angle variables, 57
fiber bundle, 10, 158
flow coordinates, 71, 72, 80, 165

generating function, 34
  examples, 37
  explicit time dependence, 39
  types 1–4, 34
gyrating charge
  in electrostatic wave, 104
Hamilton’s equations, 9
  canonical invariance, 31
  concise form, 9
Hamilton–Jacobi, 59, 60, 62, 92
  generating function, 58
Hamiltonian, 8
  conserved, 9
  time evolution, 9
Hamiltonian flow, 10
incompressibility, 10
Hamiltonian formalism, 29
  harmonic oscillator, 11, 60
  action-angle approach, 60
  Hamilton–Jacobi approach, 60
Hénon–Heiles model, 110, 181
heteroclinic intersection, 135
Hyperion model, 139, 179
  chaotic rotation, 139
  instability in 3D, 142
  movie, 179
  Poincaré section, 142
independence of functions, 4, 5, 6, 64, 74, 79, 88, 95, 158, 163
inertia tensor, 23
integrable systems, 56
  examples
    circular stadium billiard, 73
    free 2D particle, 70, 71
    free-particle examples, 69
    Hénon–Heiles type, 112
    one degree of freedom, 60
    nonseparable, 85
    separability, 57
spherical pendulum, 78
islands of stability, 131
Jacobi elliptic integral, 15
Jacobi identity, 30, 54
KAM theorem, 121, 122
nonlinear stability, 122
Kepler problem, 61
kicked oscillator, 129
Lagrange bracket, 32
canonical invariance, 32
fundamental, 33
inverse of Poisson bracket, 33
Lagrange points, 48, 127
linear stability, 48, 52
nonlinear stability, 127
Lagrangian mechanics, 7
linear oscillator, 44
linear stability, 44, 48, 52
linearized map, 137
Liouville–Arnol’d theorem, 56, 64, 68, 72, 73, 77, 82, 84, 90, 165
perturbation theory
Birkhoff–Gustavson expansion, 109
canonical, 97, 181
coupled oscillators, 102
gyrating charge, 104
simple pendulum, 98
phase portrait, 13
phase space, 10
volume, 38
phase-space velocity, 10
Poincaré invariant, 34
Poincaré section, 86, 87, 106, 108, 111, 115, 130, 131,
138, 142, 144, 146, 150, 177, 179
Poinson bracket, 29
angular momenta, 41
antisymmetry, 30
distribution over a product, 30
fundamental, 30
Jacobi identity, 30, 54
quasiperiodic motion, 108
resonance zone, 124, 125
restricted three-body problem
inertial frame, 48
Lagrange points, 50
linear stability, 52
normal modes, 53
rotating frame, 49
rigid body, 21
angular coordinates (Euler angles), 21
angular velocity, 22
degrees of freedom, 21
inertia tensor, 23
Lagrangian, 23
scalar function
time evolution, 29
sensitivity to initial conditions, 132, 145
separable systems, 57
Hamilton–Jacobi theory, 59
one degree of freedom, 60
separatrix, 13, 80, 163
small oscillations, 44
triatomic molecule, 46
small-denominator problem, 124, 142
spherical pendulum, 18, 78
action-angle variables, 82
constraint force, 20
energy–momentum diagram, 79
Hamiltonian, 19
Lagrangian, 18
monodromy, 83
reduced equation of motion, 19
stability
rotation, 13
separatrix, 13, 80, 163
period lattice, 64, 66, 68, 72, 73, 77, 82, 84, 90, 165
<table>
<thead>
<tr>
<th>Index</th>
<th>188</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lyapunov, 122</td>
<td>small oscillations, 152</td>
</tr>
<tr>
<td>nonlinear, 122, 126, 127</td>
<td>swing-plane shift, 172</td>
</tr>
<tr>
<td>stable manifold, 134, 135</td>
<td>three commuting integrals, 154</td>
</tr>
<tr>
<td>stationary group, 66</td>
<td>two-dimensional model, 149</td>
</tr>
<tr>
<td>stochastic web, 130, 131</td>
<td>constant-energy manifold, 149</td>
</tr>
<tr>
<td>chaotic orbits, 131</td>
<td>Poincaré section, 150</td>
</tr>
<tr>
<td>diffusion, 134</td>
<td>symmetric top, 23, 156</td>
</tr>
<tr>
<td>superdiffusion, 134</td>
<td>constants of the motion, 25</td>
</tr>
<tr>
<td>stochastic web-map</td>
<td>equation for $u = \cos \theta$, 25</td>
</tr>
<tr>
<td>Lyapunov exponent, 138</td>
<td>Hamiltonian, 25</td>
</tr>
<tr>
<td>swing-spring, 148</td>
<td>Lagrangian, 23</td>
</tr>
<tr>
<td>action-angle variables, 166</td>
<td>nutation period, 25</td>
</tr>
<tr>
<td>admissible integrals, 158</td>
<td>precession, 25</td>
</tr>
<tr>
<td>application in molecular modeling, 176</td>
<td>reduced equation of motion, 25</td>
</tr>
<tr>
<td>bifurcation point, 164</td>
<td>three-body problem</td>
</tr>
<tr>
<td>Birkhoff–Gustavson expansion, 152</td>
<td>restricted, 48</td>
</tr>
<tr>
<td>chaos, 149</td>
<td>Toda model, 85</td>
</tr>
<tr>
<td>constraints among the integrals, 158</td>
<td>constant-energy phase space, 86</td>
</tr>
<tr>
<td>dynamics on the level sets, 156</td>
<td>energy–momentum diagram, 89</td>
</tr>
<tr>
<td>flow coordinates, 165</td>
<td>Hénon’s second integral, 88</td>
</tr>
<tr>
<td>image $\mathcal{E}$ of energy–momentum map, 158, 160</td>
<td>Liouville–Arnol’d approach, 90</td>
</tr>
<tr>
<td>integrable approximations, 152</td>
<td>period lattice, 90</td>
</tr>
<tr>
<td>manifold $\mathcal{E}$, 158</td>
<td>total energy, 10</td>
</tr>
<tr>
<td>monodromy, 170</td>
<td>unstable manifold, 134, 135</td>
</tr>
<tr>
<td>period lattice, 165</td>
<td></td>
</tr>
<tr>
<td>Poincaré section, 2D, 150</td>
<td></td>
</tr>
</tbody>
</table>