# Notes and Corrections to IMD2.pdf 

## Notes and Corrections to IMD2: <br> Introduction to Modern Dynamics (2 ${ }^{\text {nd }}$ Edition)



Cover of IMD2

## Chapter 1. Physics and Geometry

- pg. 27 Eq. 195 The second equation should have a minus sign in front of $\omega_{\mathrm{z}}$

$$
\frac{d \hat{e}_{y}}{d t}=-\omega_{z} \hat{e}_{x}+\omega_{y} \hat{e}_{z}
$$

- pg. 34 Eq. 1.137 There should be a minus sign on the upper right term in the inertia tensor matrix.

$$
I_{a b}=\left(\begin{array}{ccc}
\int_{V}\left(y^{2}+z^{2}\right) \rho(\vec{r}) d x d y d z & -\int_{V} x y \rho(\vec{r}) d x d y d z & -\int_{V} x z \rho(\vec{r}) d x d y d z \\
-\int_{V} x y \rho(\vec{r}) d x d y d z & \int_{V}\left(x^{2}+z^{2}\right) \rho(\vec{r}) d x d y d z & -\int_{V} y z \rho(\vec{r}) d x d y d z \\
-\int_{V} x z \rho(\vec{r}) d x d y d z & -\int_{V} y z \rho(\vec{r}) d x d y d z & \int_{V}\left(x^{2}+y^{2}\right) \rho(\vec{r}) d x d y d z
\end{array}\right)
$$

- pg. 37 Eq. 1.148 The components of the displacement should be squared

$$
\sum_{k} a_{k}^{2}=a^{2}
$$

- pg. 47 Eq. 1.192 is solving for the magnitude $\left|\omega_{\perp}\right|$. There is a $90^{\circ}$ phase shift between the torque and the transverse angular velocity.


## Chapter 2. Lagrangian Mechanics

- pg. 59 Eq. 2.32 The second line should read

$$
L=\frac{I_{1}}{2}(\dot{\phi} \sin \theta \sin \psi+\dot{\theta} \cos \psi)^{2}+\frac{I_{1}}{2}(\dot{\phi} \sin \theta \cos \psi-\dot{\theta} \sin \psi)^{2}+\frac{I_{3}}{2}(\dot{\phi} \cos \theta+\dot{\psi})^{2}-M g d \cos \theta
$$

- pg. 60

Eq. 2.33 top equation should read

$$
\frac{\partial L}{\partial \theta}=\left(I_{1}-I_{3}\right) \dot{\phi}^{2} \cos \theta \sin \theta-\left(I_{3} \dot{\psi} \dot{\phi}-M g d\right) \sin \theta
$$

Eq. 2.34 The top line should read

$$
p_{\theta}=\frac{\partial L}{\partial \dot{\theta}}=I_{1} \dot{\theta}
$$

- pg. 61 The condition on $\theta$ for Eq. 2.42 is $\cos \theta=0$
- pg. 65 Eq. 2.59 The potential should be $\mathrm{V}=-\mathrm{mgy}$ (because y is increasing downward). The sign is correct in the Lagrangian.
- pg. 72 Eq. 2.98 The gravitation potential energy should be un-italic as

$$
V(r)=-\frac{G M m}{r}
$$

## Chapter 3. Hamiltonian Mechanics

- pg. 88 Example 3.2: The Lagrangian is missing a square on the $\dot{\phi}$.
- pg. 98 Example 3.5: The Hamiltonian is expressed in terms of the conjugate momentum as

$$
H=\frac{J^{2}}{2 I}
$$

When re-expressing the energy in terms of J and $\omega$, the energy is

$$
E=\frac{1}{2} \omega J
$$

Note that applying Hamilton's equations to the first expression yields the correct angular frequency $\omega$, but not for the second. Hamilton's equations, because of the partial derivatives, must be applied to the correct form of the Hamiltonian that emerges from the Legendre transform of the Lagrangian. The second equation is useful for solving adiabatic invariance problems, but not for using Hamilton's equations.

## Chapter 4. Nonlinear Dynamics and Chaos

- pg. 128 Eq. 4.46 should be

$$
\begin{aligned}
& \dot{u}=\mu \omega_{0} u\left[1-\frac{\beta^{2}}{2}\left(u^{2}+v^{2}\right)\right] \\
& \dot{v}=\mu \omega_{0} v\left[1-\frac{\beta^{2}}{2}\left(u^{2}+v^{2}\right)\right]
\end{aligned}
$$

- pg. 130 Example 4.4: The limits of integration for the integral over dr is from $r_{0}$ to $r_{1}$. The limit of integration over time is from $t=0$ to $t=T=2 \pi$.
- pg. 136-137 The Feigenbaum number $\delta$ is given by the inverse of the ratio of intervals

$$
\delta=\lim _{n \rightarrow \infty} \frac{S_{n+1}-S_{n}}{S_{n+2}-S_{n+1}}
$$

-pg. 150 HW Problem 4.3d: There should be a "dot" over the " $y$ " for the second equation.

- pg. 153 HW 4.24. The equations should be

$$
\begin{aligned}
& \dot{x}=y \\
& \dot{y}=b \sin z-\mu y\left(x^{2}-a\right)-x \\
& \dot{z}=1
\end{aligned}
$$

- pg. 153 HW 4.28. The equations should be

$$
\begin{aligned}
& \dot{x}=\alpha(y-x-h(x)) \\
& \dot{y}=x-y+z \\
& \dot{z}=-\beta y
\end{aligned}
$$

## Chapter 5. Hamiltonian Chaos

- pg. 154 The figure is NOT the human protein interactome! It is a Hamiltonian tapestry.
- pg. 157 In Eq. 5.4 the argument I should be $\mathcal{J}$.
- pg. 167 In Fig. 5.10, the parameter $\mathrm{C}=0.01$ is the parameter K of Eq. 5.21. Also, in Fig. 5.11, the parameter $\varepsilon$ is also the parameter K . The threshold for the dissolution of the last open orbit is $\mathrm{K}=0.97$.


## Chapter 6. Coupled Oscillators and Synchronization

## Chapter 7. Network Dynamics

- pg. 217 Eq. 7.33. The sum is over all links, so there are not self-connections. Thus:

A population of N phase oscillators can be coupled globally described by the flow

$$
\begin{equation*}
\frac{d \phi_{k}}{d t}=\omega_{k}+g \frac{1}{N-1} \sum_{j \neq k}^{N} \sin \left(\phi_{j}-\phi_{k}\right) \tag{7.33}
\end{equation*}
$$

in which the coupling constant g is the same for all pairs of oscillators.

- pg. 228 Fig. 7.14. The equation should be $S=1-\exp (-\langle k\rangle S)$.
- pg. 237 Eq . 7.71 The minus in front of the "mu" should be plus on the second line

$$
\frac{d r}{d t}=\mu i-v r
$$

## Chapter 8. Evolutionary Dynamics

- pg. 244 The equations should read

$$
\begin{aligned}
& \dot{x}=x(3-x-2 y) \\
& \dot{y}=y(2-x-y)
\end{aligned}
$$

Chapter 9. Neurodynamics and Neural Networks

## Chapter 10. Economic Dynamics

## Chapter 11. Metric Spaces and Geodesic Motion

## Chapter 12. Relativistic Dynamics

- pg. 389 These Lorentz transformations suffered catastrophic failure during the typesetting and proofing process at the publisher. The correct Lorentz transformations are

$$
\begin{array}{llrl}
\begin{array}{l}
\text { Lorentz } \\
\text { Transformations }
\end{array} & t^{\prime} & =\gamma\left(t-\frac{v}{c^{2}} x\right) & \\
& & =\gamma\left(t^{\prime}+\frac{v}{c^{2}} x^{\prime}\right) \\
x^{\prime} & =\gamma(x-v t) & x & =\gamma\left(x^{\prime}+v t^{\prime}\right) \\
y^{\prime} & =y & y & =y^{\prime} \\
z^{\prime} & =z & z & =z^{\prime}
\end{array}
$$

- pg. 421 For Eq. 12.119 there is a missing equals sign. The equations should read

$$
\begin{align*}
& u^{0}+u^{1}=c \exp \left(\frac{g \tau}{c}\right) \\
& u^{0}-u^{1}=c \exp \left(-\frac{g \tau}{c}\right) \tag{12.119}
\end{align*}
$$

Chapter 13. The General Theory of Relativity and Gravitation

## Appendix.

