

Physics 681: Solar Physics and Instrumentation – Lecture 1

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Center for Solar–Terrestrial Research



Class Organization

- ❑ *Textbook:* The Sun – An Introduction, Michael Stix, Springer Verlag, 2004
- ❑ *Time:* Tuesday and Thursday, 10:00 am - 11:25 am, Room FAC 305
- ❑ *Office Hours:* Open-door policy, 9:00 am - 5:00 pm, Room T 403
- ❑ *E-Mail:* cdenker@adm.njit.edu
- ❑ *Homework:* Reading assignments to be completed *before* the corresponding lectures!
- ❑ *Grades:* In-class presentation (20%), mid-term exam (25%), participation (15%), and final exam (40%)
- ❑ *Grading Scale:* A > 90%, B+ > 75%, B > 60%, C+ > 50%, C > 40%, and F ≤ 40%
- ❑ *Syllabus:* <http://solar.njit.edu/~cdenker/physics681.html>

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In-Class Presentation

- PowerPoint presentation
- 20 minutes talk plus discussion
- No more than 20 slides
- The topics are based on recent review papers
- The presentation has to be discussed with the instructor one week before it is scheduled



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Topics of the Presentations

- Aschwanden, M. J., Poland, A. I., Rabin, D. M., 2001: *The New Solar Corona*. Annual Review of Astronomy and Astrophysics **39**, 175-210 (Joseph)
- Fisher, G. H., Fan, Y., Longcope, D. W., Linton, M. G., Pevtsov, A. A., 2000: *The Solar Dynamo and Emerging Flux*. Solar Physics **192**, 119-139 (Angelo)
- Fröhlich, C., Lean, J., 2004: *Solar Radiative Output and its Variability: Evidence and Mechanisms*. The Astronomy and Astrophysics Review **12**, 239-271 (Preethi)
- Martin, S. F., 1998: *Conditions for the Formation and Maintenance of Filaments*. Solar Physics **182**, 107-137 (Sam)
- Priest, E. R., Forbes, T. G., 2002: *The Magnetic Nature of Solar Flares*. The Astronomy and Astrophysics Review **10**, 313-377
- Thomas, J. H., Weiss, N. O., 2000: *Fine Structures in Sunspots*. Annual Review of Astronomy and Astrophysics **42**, 517-548 (Garrett)
- Thompson, M. J., Christensen-Dalsgaard, J., Miesch, M. S., Toomre, J., 2003: *The Internal Rotation of the Sun*. Annual Review of Astronomy and Astrophysics **41**, 599-643



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Mid-Term Exam

- ❑ The mid-term exam is a written assignment describing an instrument used in solar physics
- ❑ Your choice has to be coordinated with instructor to avoid “duplication” of efforts
- ❑ You have to choose an instrument by September 15, 2005
- ❑ To level the playing field, we will use the style and format of a letter submission to *The Astrophysical Journal* (4 pages maximum, double column, LaTeX)
- ❑ Deadline for the assignment is October 27, 2005 (No Exceptions!)
- ❑ We will use <http://TurnItIn.com/> to ensure academic integrity



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Final Exam and Participation

- ❑ The final exam will have a format similar to what you might encounter in the general physics qualifying exam
- ❑ One month before the exam, we will narrow the focus of the exam down to four chapters of Stix's book
- ❑ You still have to know the other chapters as background information
- ❑ Active in-class participation is expected and will be part of the final grade
- ❑ Group work and occasional group assignments are integral part of our class (Be Prepared!)

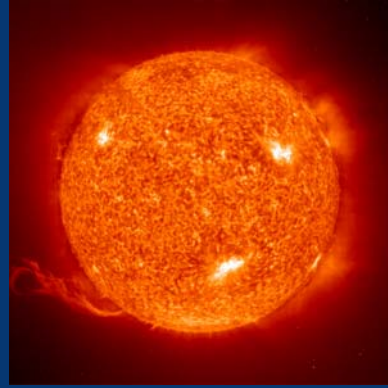


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Characteristics of the Sun

- Distance
- Mass
- Radius
- Luminosity
- Spectral Energy Distribution
 - Energy Flux
 - The Visible
 - The Infrared
 - The Radio Spectrum
 - The Ultraviolet
 - EUV and X-Rays
 - Color Indices



<http://sohowww.nascom.nasa.gov/>



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Elliptical Orbits

- *Kepler's 1st Law:* A planet orbits the Sun in an ellipse, with the Sun at one focus of the ellipse.
- *Kepler's 2nd Law:* A line connecting a planet to the Sun sweeps out equal areas in equal time intervals.
- *Kepler's 3^d Law:* The average orbital distance a of a planet from the Sun is related to the planet's sidereal period P by: $P^2 = a^3$



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Energy and Angular Momentum

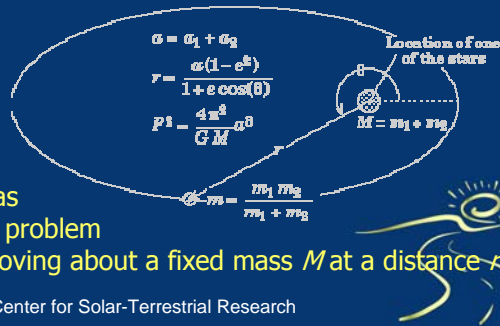
$$E = \frac{1}{2} m_1 |\vec{v}_1|^2 + \frac{1}{2} m_2 |\vec{v}_2|^2 - G \frac{m_1 m_2}{|\vec{r}_2 - \vec{r}_1|}$$

$$E = \frac{1}{2} \mu v^2 - G \frac{M \mu}{r} \quad \left(v = |\vec{v}|, \vec{v} \equiv \frac{d\vec{r}}{dt}, \text{ and } \vec{r} = \vec{r}_2 - \vec{r}_1 \right)$$

$$\vec{L} = m_1 \vec{r}_1 \times \vec{v}_1 + m_2 \vec{r} \times \vec{v}_2$$

$$L = \mu \vec{r} \times \vec{v} = \vec{r} \times \vec{p}$$

In general, the two-body problem may be treated as and equivalent one-body problem with the reduced mass moving about a fixed mass M at a distance r .



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Kepler's 2nd Law

$$\frac{d\vec{L}}{dt} = \frac{d}{dt} (\vec{r} \times \vec{p}) = \frac{d\vec{r}}{dt} \times \vec{p} + \vec{r} \times \frac{d\vec{p}}{dt} = \vec{v} \times \vec{p} + \vec{r} \times \vec{F} = 0!$$

$$dA = dr (r d\theta) = r dr d\theta = \frac{1}{2} r^2 d\theta \Rightarrow \frac{dA}{dt} = \frac{1}{2} r^2 \frac{d\theta}{dt}$$

$$\vec{v} = \vec{v}_r + \vec{v}_\theta = \frac{dr}{dt} \hat{r} + r \frac{d\theta}{dt} \hat{\theta} \Rightarrow \frac{dA}{dt} = \frac{1}{2} r v_\theta$$

$$r v_\theta = |\vec{r} \times \vec{v}| = \frac{|\vec{L}|}{\mu} = \frac{L}{\mu} \Rightarrow \frac{dA}{dt} = \frac{1}{2} \frac{L}{\mu}$$

The time rate of change of the area swept out by a line connecting a planet to the focus of an ellipse is a constant.

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