# Physics 535 Physics of Lightning – Course Information

Texts:
Lightning: Physics and Effects (Rakov and Uman) -- One copy on Reserve
Spark Discharge (Bazelyan and Raizer)

Readings:

1. Are from the texts. OR
2. Are handed out in class OR
3. If available electronically, are posted on the course web-site OR (http://www.physics.nmt.edu/~rsonnenf/phys535/phys535.html)
4. Are on reserve at the library

**I will assign problems via handouts or updates to the course web-page.**

**Students also are asked to compose 3-4 problems/week based on the readings.** The student should know how to solve two of them. The others can be more "interesting", and they may be vaguely defined. We can discuss them in class and see if they can become better defined or solvable.

Students are also asked to locate and review an additional paper/month on a topic of interest and present the principal results to the class.

**Grades –** The course grade is primarily based on participation (including in-class presentations) and homework. Homework consists of reading assignments and summaries, traditional problem solving, and computer modeling/data analysis. The expectation is that we all will be present and involved and diligent about solving problems and helping each other clarify this complex area.

**Computing Facilities** -- You will be analyzing real data using *Matlab* and a custom software package called *xlma*. Both packages are available on the physics department computers in Workman 326. You may select languages other than Matlab for your work, but I will not be able to assist you if you do.

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How to use XLMA on Physics Computer Lab
1) Open terminal in your home directory
2) cp /usr/local/nfs/lma/xlma.sav ~/
3) idl -vm
4) First dialog box, select xlma.sav on right then click OK.
5) Next dialog asks to locate lma_lib; click OK.
6) Next dialog box says welcome; click OK.
7) Next asked to load preferences; click No.
8) Asked to locate lma_lib; click OK.
Now you are ready to load data!

1) Menu File -> Read data -> Read anywhere data
2) In dialog box browse to /usr/local/nfs/lma/
3) Select data (e.g. LYLOUT_000705_220000_0600.dat.gz); Click OK.
4) Asked for NLDN file; Click No.
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Approximate Schedule of Topics

Week1 – Read Ch. 1 and 2, Rakov (Overview and the global electrical circuit)
1) 8/24: Powerpoint – Overview of lightning and connections with other field. Introduction to xlma.

2) 8/26: Conductivity in gasses. Introduction to mobility. Measurement of conductivity of air with a parallel plate capacitor. Definition of current density, conductivity, potential, etc.
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Week 2 – Read Ch 3 (through 3.2.5), and Behnke
3) 8/31: Derivation of continuity equation and application to the electrostatic model of the global electric circuit. Inverse exponential relation between conductivity and fair-weather electric field. Review of principles underlying chapter 2 of Rakov.

4) 9/2: Introduction to electrostatics, image charges and the dipole model of storms. Field reversal distance.
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Week 3 – Read remainder of Ch. 3 and "The Thundercloud" (Vonnegut and Moore)
5) 9/7: Data on electric fields in real storms. Data on lightning electric fields, compare CG and IC field changes. Potential and electric fields for a slab of charge and a disc of charge. Screening charges.
Read Ch. 3 charging mechanisms.

6) 9/9: LMA lab day. LMA data analysis.
Analyze E-field data
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Week 4 – Read Ch. 4 (Negative CGs) , Sigelsheim incident, Moore (lightning rods)
9/14 Terminal velocity and cloud electrification. Inductive mechanism
Analyze Field-change data

9/16 Non-inductive mechanism
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Week 5 (9/21 – 9/23)
Read Ch. 5 Rakov (Positive CGs), Winn and Standler, and Williams on positive discharges.

Correlate LMA and field-change data
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Week 6 Read Ch. 9 Rakov (IC discharges), Read Uman on return-stroke models
9/28 – 9/30
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Week 7 Read Ch. 11 Rakov (Thunder), Continue Return stroke models
10/5 – 10/7
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Week 8 -- Read Ch. 1 and Ch 2 through 2.3 in Bazelyan, Continue Return stroke models
10/12 – 10/14 (Midsemester) [APS 4Corners, 10/15-10/16]

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Week 9 – Read Ch. 2.4 to end in Bazelyan – Processes in ionized gasses
10/19 – 10/21
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Week 10 – Read Ch 3 through 3.2.3 – Processes in spark breakdown
10/26 – 10/28
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Week 11 – Ch. 3 in Bazelyan through end. -- Streamer breakdown
11/2 – 11/4
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Week 12 – Ch. 6 to 6.5  -- The leader process
11/9 – 11/11 – Ch. 5 in Bazelyan
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Week 13 – Ch. 6.5 to end -- The leader process
11/16 – 11/18
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Week 14  Ch. 6 in Bazelyan
11/23 only (Thanksgiving)
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Week 15 – Special topics (student presented papers)
11/30 – 12/2
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Week 16 – Special topics (student presented papers)
12/7 – 12/9 (Dead week)
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AGU 12/13-17