

# A COSMIC RAY BIBLIOGRAPHY (Books, papers and internet sites)

## ULR LISTS

<http://www.mpi-hd.mpg.de/hfm/CosmicRay/CosmicRaySites.html> This site is a 10-page listing of links regarding cosmic rays, high-energy particles, etc.

<http://www.aps.org/resources/particle.html>  
A great list of sources for the study of particle physics.

<http://quarknet.fnal.gov/run2/biblio.html>  
Another great place to start looking for resources.

<http://sln.fi.edu/tfi/hotlists/physical.html> Created by Franklin Institute Science Museum with numerous physics links.

## THE HIGH SCHOOL PROJECTS

ALTA Alberta Large Area Time coincidence Array  
<http://csr.phys.ualberta.ca/~alta/Pages/Sitemap.html>

CHICOS California High School Cosmic Ray Observatory  
<http://www.chicos.caltech.edu>

CROP Cosmic Ray Observatory Project  
<http://physics.unl.edu/~gsnow/crop/crop.html>

NALTA North American Large Area Time Coincidence Arrays  
<http://csr.phys.ualberta.ca/nalta/>

NYSCPT New York Schools Cosmic Particle Telescope  
<http://www.physics.nyu.edu/NYSCPT>

SALTA Snowmass-Area Large Time Coincidence Array  
<http://faculty.washington.edu/~wilkes/salta/salta-science.html>

WALTA Washington Large Area Time Coincidence Array  
<http://www.phys.washington.edu/~walta>

PITT-UMST The CosRay High School Project  
<http://www.phyast.pitt.edu/~jth/scied/quarknet/qnet.html>

Preston College. A UK college, which has some detectors at a couple high schools  
<http://www.prestoncoll.ac.uk/cosmic>

SEASA Stockholm Educational Air Shower Array  
<http://gluon.particle.kth.se/SEASA/>

SCROD School Cosmic Ray Outreach Program  
<http://www.hep.physics.neu.edu/scrod>

SKY VIEW University of Wuppertal (Germany)  
<http://skyview.uni-wuppertal.de>  
(Note: this may involve high schools)

INDIANA UNIVERSITY QUARKNET  
<http://www.physics.indiana.edu/~quarknet>

This is an excellent site from a summer workshop where the high school students helped from day one in the project. Teams were established for Theory, Web, Electrical and Mechanical development. Nice notes and images

## **PAPERS FROM HIGH SCHOOL STUDENTS**

*The Effect of Foil Wrapping on Scintillator Efficiency*  
Carney, Fendrick, Greer, Marian High School, Omaha  
April 4, 2001  
<http://marian.creighton.edu/~tfendric/foil.html>

*Correlation between Barometric Pressure and Cosmic Ray Intensity*  
Batten, Karr, Marian High School, Omaha  
March 23, 2001  
<http://marian.creighton.edu/~besser/physics/barometer.html>

*JavaScript Distance Calculator*  
Greer, Sedlacek, Marian High School, Omaha  
April 9, 2001  
<http://marian.creighton.edu/~besser/physics/crop/distance.html>

## **SIMULATIONS BASED ON EXTENSIVE AIR SHOWERS (EAS)**

Milagro Animations  
<http://scipp.ucsc.edu/milagro/Animations/Pages/MilAnimIndex.html>

Milagro Animations EAS  
<http://scipp.ucsc.edu/milagro/Animations/Pages/EASIndex.html>

CORSIKA or Cosmic Ray Simulations for Cascade  
<http://www-ik3.fzk.de/~heck/corsika/>

## OTHER SIMULATIONS

<http://www.bun.falkenberg.se/gymnasium/amnen/fysik/millikaneng.html> A simulation of the Millikan Oil Drop Experiment

<http://physics.nad.ru/start.htm> An amazing site with numerous simulations of physical phenomena. Downloads of some animations are available as is a CD Rom.

### **28<sup>th</sup> INTERNATIONAL COSMIC RAY CONFERENCE** (Tokyo, Japan)

The papers listed are not yet available as of the time of this writing (7/15/03) from the Conference site. However, they should be available relatively soon.

<http://www-rccn.icrr.u-tokyo.ac.jp/icrc2003/>

*SEASA: The Stockholm Educational Air Shower Array*, Mark Pearce, et al.

[http://www-rccn.icrr.u-tokyo.ac.jp/icrc2003/proceedings\\_pdf.html](http://www-rccn.icrr.u-tokyo.ac.jp/icrc2003/proceedings_pdf.html)

*SCROD: School Cosmic Ray Outreach Program*, John David Swain, et al.

<http://arxiv.org/ps/astro-ph/0305208>

*CHICOS Detector Stations*, Robert D McKeown

[http://www-rccn.icrr.u-tokyo.ac.jp/icrc2003/proceedings\\_pdf.html](http://www-rccn.icrr.u-tokyo.ac.jp/icrc2003/proceedings_pdf.html)

*WALTA Progress Report*, Gichard Gran, et al.

[http://www-rccn.icrr.u-tokyo.ac.jp/icrc2003/proceedings\\_pdf.html](http://www-rccn.icrr.u-tokyo.ac.jp/icrc2003/proceedings_pdf.html)

### **FERMI LAB BOARD SITE (this might be important someday)**

<http://www.phys.washington.edu/~berns/WALTA/Qnet2/>

## MOVIES

<http://www-star.stanford.edu/~vlf/optical/fly/>

<http://www-star.stanford.edu/~vlf/optical/fly> A short 1MB movie of an “elf flash” as would be seen by the Fly Eye detector.

<http://www.lalanet.gr.jp/nsm/E-radiation.html> A very interesting site from a Japanese University, which includes video clips of produced tracks in an elaborate cloud chamber.

*The Cosmic Connection* by Tim Middleton, a teacher from Austin, Texas. From what I read the video describes cosmic rays and shows how they are detected. It is “suitable for grades 6-12.”

[http://www.shsu.edu/~chm\\_tgc/sounds/pushmovies/pmt.html](http://www.shsu.edu/~chm_tgc/sounds/pushmovies/pmt.html) A flash animation movie of the operation of a PMT. Simple but effective.

[http://microcosm.web.cern.ch/Microcosm/RF\\_cavity/ex.html](http://microcosm.web.cern.ch/Microcosm/RF_cavity/ex.html) An interactive video where you must flip batteries to move a proton through accelerator magnets.

### **EDUCATIONAL BACKGROUND MATERIAL (books and URLs)**

**Dave and I agree that the most logically presented material is found at the CHICOS Workshop site. It should provide an outline and the material for an explanation of not only cosmic rays but the use of Scintillator/PMT detectors.**

<http://www.chicos.caltech.edu/collaboration/workshop.html>

**An absolutely must read: (it should be required for all physics teachers)**

Trefil, James. *From Atoms to Quarks*. (        Press, 19 )

**Another absolutely must read: (this is meant for a general audience)**

Friedlander, Michael W. *Cosmic Rays*, (Harvard University Press, 1989)

Schwarz, Cindy, *A Tour of the Subatomic Zoo*, (AIP Press, 2<sup>nd</sup> ed, 1997) A truly great intro to the standard model with great diagrams and tables explaining the nature of subatomic particles. The book is the basis of a six week course taught at Vassar by the author.

<http://archive.ncsa.uiuc.edu/Cyberia/Expo/information-pavilion.html> University of Illinois site focuses on astronomy, astrophysics and virtual environments with ell-designed deep content.

Others:

A reference book to help you understand the electronics:

Leo, W. R., *Techniques for Nuclear and Particle Physics Experiments*. (Springer-Verlag, 2<sup>nd</sup> Ed. 1994) See chapter 14 on the Electronics for Pulse Signal Processing for an explanation of the role of gates, discriminators, coincidence units and the like.

Gaisser, Tom, *Cosmic Rays and Particle Physics*. (Cambridge Univ. Press, 1991)

Rossi, Bruno, *High Energy Particles*. (Prentice-Hall, 1952). The classic.

Gruppen, Claus, *Particle Detectors*. (Cambridge, 1996) Very detailed description of how scintillation counters function, chapter 5.

Perkins, D.H., *Introduction to High Energy Physics*. (Addison-Wesley, 1999)

Hamming, Richard W, *The Art of Probability for Scientists and Engineers*. (Addison-Wesley, 1991) A book written in a way that makes stats understandable.

## Popular Magazine Articles

Cronin, Gaisser and Swordly, "Cosmic Rays at the Energy Frontier" Scientific American, January 1997. This article gives an overview of the study of cosmic rays.

Irion, Robert, "Physicists Prepare to Catch Cosmic Bullets." Science, 21 June 2001. About the Pierre Auger Observatory.

See The Cosmic and Heliospheric Learning Center, which provides links to recent articles. <http://helios.gsfc.nasa.gov>

## LESSON PLANS and DEMOS (you don't need to invent the wheel)

<http://outreach.physics.utah.edu/javalabs/java102/hess/index.htm> This the index page for the Astrophysics Science Project Integrating Research and Education (wow!). At this time it contains 5 "Activities" which are virtual labs. They include Hess' Balloon Ride, Particle Direction, Angle of Particle Arrival, Average Velocity and Maximizing Recorded Events.

There is a Teacher Page in addition to the Student Lab. There was a mention on one site that these at times do not work.

<http://www.chicos.caltech.edu/classroom/shower/reconstruct1.html> A lab from CHICOS involving the reconstruction of an EAS from ground level directional data. It is a paper and pencil lab but does demonstrate the means to determine the direction of the primary particle.

<http://quarknet.fnal.gov/projects/summer00/index.shtml> Eight virtual activities from Quarknet.. I had time to review one, "Recognizing Particle Signatures". It actually contained seven "Challenges" involving the identification and measuring of particles. The diagrams are very nice.

[http://imagine.gsfc.nasa.gov/docs/ask\\_astro/ask\\_an\\_astronomer.html](http://imagine.gsfc.nasa.gov/docs/ask_astro/ask_an_astronomer.html) Not lesson plans but a resource to use, Ask a High Energy Astronomer service. There are some lesson plans under the "teacher" link. They deal with gamma rays, but might be usable.

Breden, Thomas and Weber, Photo Multiplier Demonstration, Scintillator Demonstration, Positioning Arrays and Finding Your Exact Location from CosRay students. You should have a copy of this.

<http://www.ins.cornell.edu/public/outreach/CloudChamber.doc> A great lesson plan in the construction, use and results of a cloud chamber and cosmic rays. It includes a Teacher's Guide with post lab questions. Nice diagrams of collisions.

<http://www.lns.cornell.edu/public/outreach> This is the main link that contained the previous referred to lesson plan. It has many other activities that are worth investigating including lesson plans in particle physics.

[http://onlineclassroom.bnl.gov/teachers/solar\\_neutrinos/lesson\\_plans/high/Dippin\\_Dot\\_Neutrinos.doc](http://onlineclassroom.bnl.gov/teachers/solar_neutrinos/lesson_plans/high/Dippin_Dot_Neutrinos.doc) This appears to be a great lab from Brookhaven National Labs involving the use of three flavors of Dippin' Dot Ice Cream to represent electron neutrinos, muons, and tau neutrinos.

[http://onlineclassroom.bnl.gov/teachers/cosmic\\_rays/index.html](http://onlineclassroom.bnl.gov/teachers/cosmic_rays/index.html) A powerpoint presentation of the construction and use, including data, of "The Muon in the Bottle" lab. This involves the use of PMT and water bottles to detect muons using Cherenkov light. Interesting comments on the Berkeley board.

<http://www.cybermeme.net/muon1.html> An interesting detector system using two Geiger counters connected with a coincidence counter. It includes directions, data and data evaluation with photos.

<http://pdg.web.cern.ch/pdg/particleadventure/index.html> Website from Berkeley including seven activities under the Educational link.

<http://www.deepspace.ucsb.edu/rot.htm> Not really a particle site but a site that allows students to operate a telescope remotely, download images and a 180 page curriculum manual is available.

<http://physicsweb.org/resources/Education/Exercises> Physics Around the World's Educational Section. Some useful links to physics exercises and experiments although not many on particle physics.

<http://jersey.uoregon.edu/vlab/index.html> Physics applets by U of Oregon Physics dept. Experiments provide conceptual interface to the equations and simulate real physics experiments. No specific cosmic ray experiment however.

### **ON LINE PARTICLE PHYSICS COURSES (with notes)**

[http://www.physics.usyd.edu.au/hienergy/4thyear\\_lectures\\_2001.html](http://www.physics.usyd.edu.au/hienergy/4thyear_lectures_2001.html) A course taught at a college in New Zealand with notes for some units.

<http://www.quark.lu.se/~eerola/fys225.html> Particle course with nice notes for nearly all chapters. Some of the notes could be used as overheads during lectures

[http://www.cabrillo.cc.ca.us/divisions/mse/phys/joes\\_thesis/](http://www.cabrillo.cc.ca.us/divisions/mse/phys/joes_thesis/) Not really a complete course but a group of web pages with nice explanations of the development of a cosmic-ray induced EAS and the lateral and temporal distribution of EAS.

<http://www.phys.washington.edu/~jeff/courses> teaches numerous particle physics courses at the University of Washington, for example, Ultra High Energy Cosmic Rays and Experimental Particle Astrophysics. He includes notes and slides for his courses.

[http://faculty.washington.edu/~wilkes/salta/talks/D-Claes\\_SALTA\\_Charged\\_Interactions\\_files/frame.htm](http://faculty.washington.edu/~wilkes/salta/talks/D-Claes_SALTA_Charged_Interactions_files/frame.htm) An introductory power point presentation by D. Claes regarding the interaction of charged particles with matter. It was presented at a SALTA workshop

## **VIRTUAL OSCILLOSCOPES**

<http://www.virtual-oscilloscope.com> Still a work in progress, but a useful shockwave based oscilloscope program for teaching the basic of using a scope.

## **PEOPLE DIRECTORY**

<http://www.slac.stanford.edu/spires/hepname/> A database of 37,000 e-mail addresses of people associated with particle physics and related fields.