

PARTICLE PHYSICS: FORCES AND PARTICLES

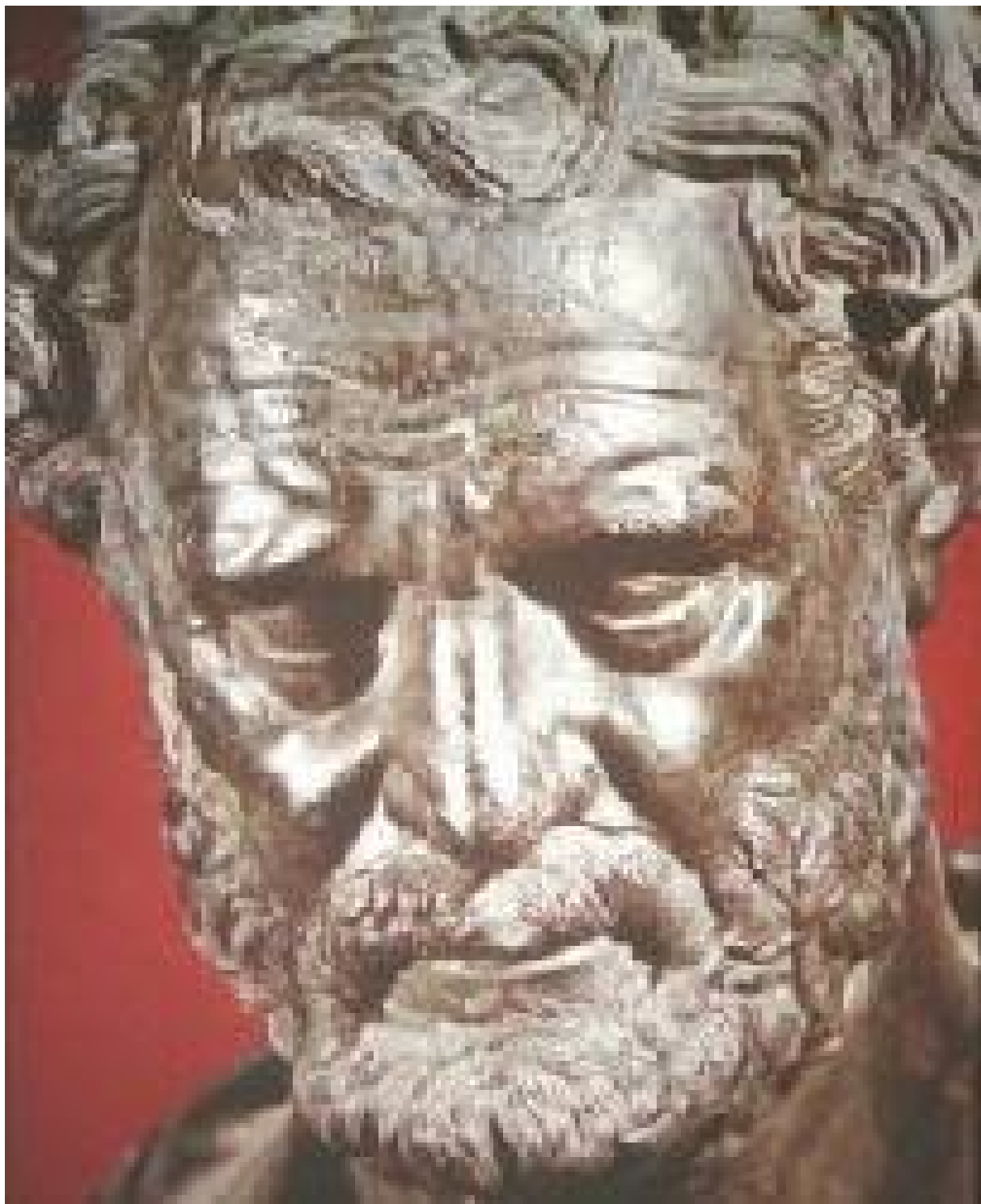
Prof. Stephen Sekula
(4/15/2010)

Supplementary Material for
PHY 3305 (Modern Physics)
Harris, Ch. 12.1-12.3

TABLE OF CONTENTS

- Review
- A History of Bricks
- Predicting New Particles
- Meet the families





Periodic Table of Elements

 Weight

 Names

 Electrons

 Wide

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
1	H Hydrogen 1.00794																	2	He Helium 4.002602
2	Li Lithium 6.941	Be Beryllium 9.012182	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border: 1px solid black; padding: 5px;"> 3 Li Lithium 6.941 </div> <div style="border: 1px solid black; padding: 5px;"> 2 1 </div> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="border: 1px solid black; padding: 5px;"> Metalloids </div> <div style="border: 1px solid black; padding: 5px;"> Other nonmetals </div> <div style="border: 1px solid black; padding: 5px;"> Halogens </div> <div style="border: 1px solid black; padding: 5px;"> Noble gases </div> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="border: 1px solid black; padding: 5px;"> Alkali metals </div> <div style="border: 1px solid black; padding: 5px;"> Alkaline earth metals </div> <div style="border: 1px solid black; padding: 5px;"> Lanthanoids Actinoids </div> <div style="border: 1px solid black; padding: 5px;"> Transition metals </div> <div style="border: 1px solid black; padding: 5px;"> Post-transition metals </div> </div> <div style="margin-top: 10px;"> <input type="text" value="273"/> </div>																
3	Na Sodium 22.98976928	Mg Magnesium 24.3050																	4
4	K Potassium 39.0983	Ca Calcium 40.078	Sc Scandium 44.955912	Ti Titanium 47.867	V Vanadium 50.9415	Cr Chromium 51.9961	Mn Manganese 54.938045	Fe Iron 55.845	Co Cobalt 58.933195	Ni Nickel 58.6934	Cu Copper 63.546	Zn Zinc 65.38	Ga Gallium 69.723	Ge Germanium 72.64	As Arsenic 74.92160	Se Selenium 78.96	Br Bromine 79.904	Kr Krypton 83.798	
5	Rb Rubidium 85.4678	Sr Strontium 87.62	Y Yttrium 88.90585	Zr Zirconium 91.224	Nb Niobium 92.90638	Mo Molybdenum 95.96	Tc Technetium (98)	Ru Ruthenium 101.07	Rh Rhodium 102.90550	Pd Palladium 106.42	Ag Silver 107.8682	Cd Cadmium 112.411	In Indium 114.818	Sn Tin 118.710	Sb Antimony 121.760	Te Tellurium 127.60	I Iodine 126.90447	Xe Xenon 131.293	
6	Cs Caesium 132.90545196	Ba Barium 137.327	57-71	Hf Hafnium 178.49	Ta Tantalum 180.94788	W Tungsten 183.84	Re Rhenium 186.207	Os Osmium 190.23	Ir Iridium 192.217	Pt Platinum 195.084	Au Gold 196.966569	Hg Mercury 200.59	Tl Thallium 204.3833	Pb Lead 207.2	Bi Bismuth 208.98040	Po Polonium (209)	At Astatine (210)	Rn Radon (222)	
7	Fr Francium (223)	Ra Radium (226)	89-103	Rf Rutherfordium (261)	Db Dubnium (268)	Sg Seaborgium (271)	Bh Bohrium (272)	Hs Hassium (270)	Mt Meitnerium (276)	Ds Darmstadtium (281)	Rg Roentgenium (280)	Cn Copernicium (285)	Uut Ununtrium (284)	Uuq Ununquadium (289)	Uup Ununpentium (288)	Uuh Ununhexium (293)	Uus Ununseptium (293)	Uuo Ununoctium (294)	

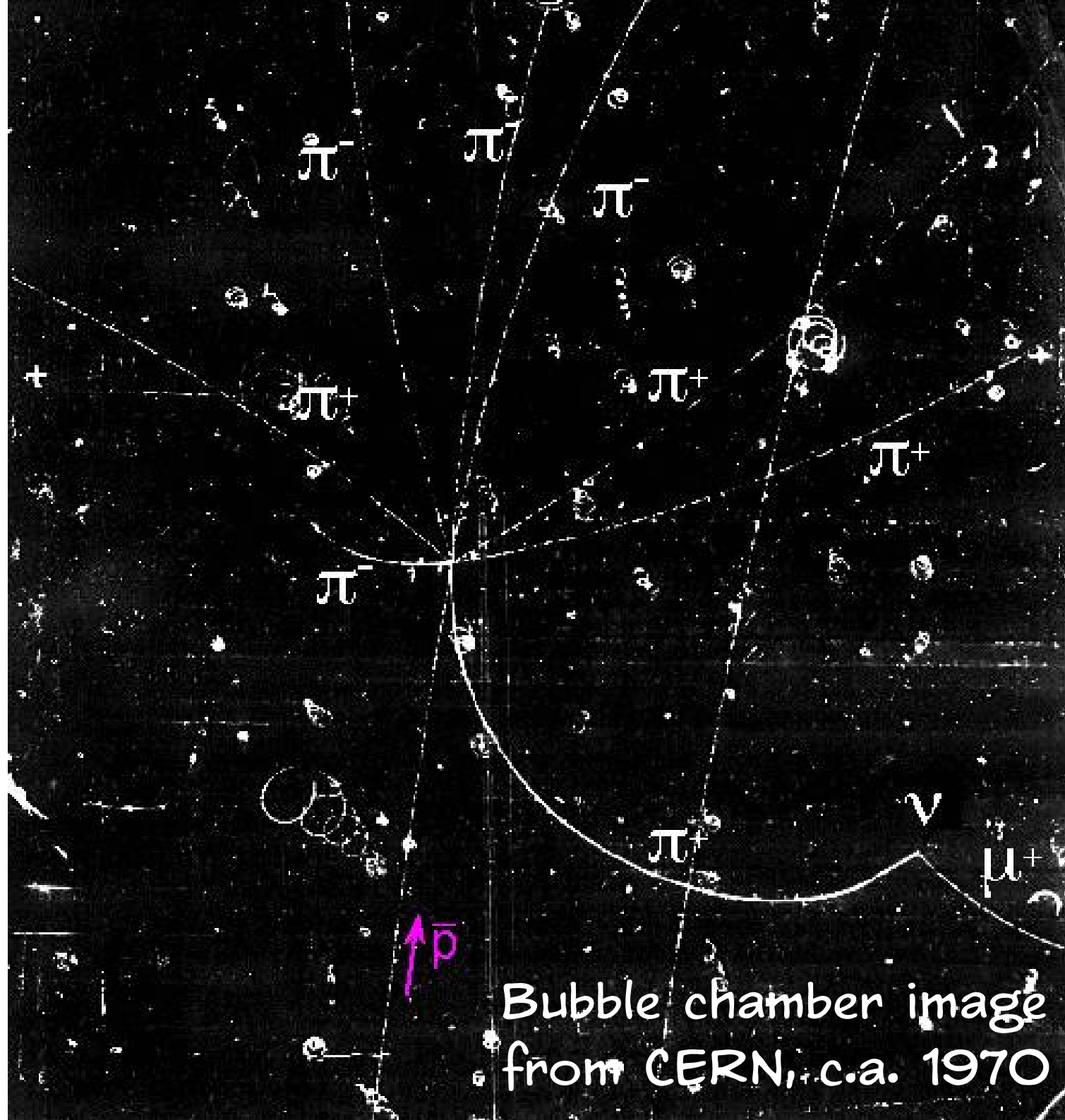
www.privatehand.com/flash/elements.html

A BRIEF HISTORY OF SUBATOMIC PARTICLES

- Electron
 - J. J. Thompson (1896): identified electrons as unique particles
- Photon
 - Hertz/Einstein (1887,1905): photoelectric effect and explanation
- Proton
 - Rutherford (1919): recognized fundamental nature of hydrogen nucleus
- Neutron
 - Chadwick (1932): distinguished this neutral radiation from photons and identified them as unique particles

THE PARTICLE EXPLOSION

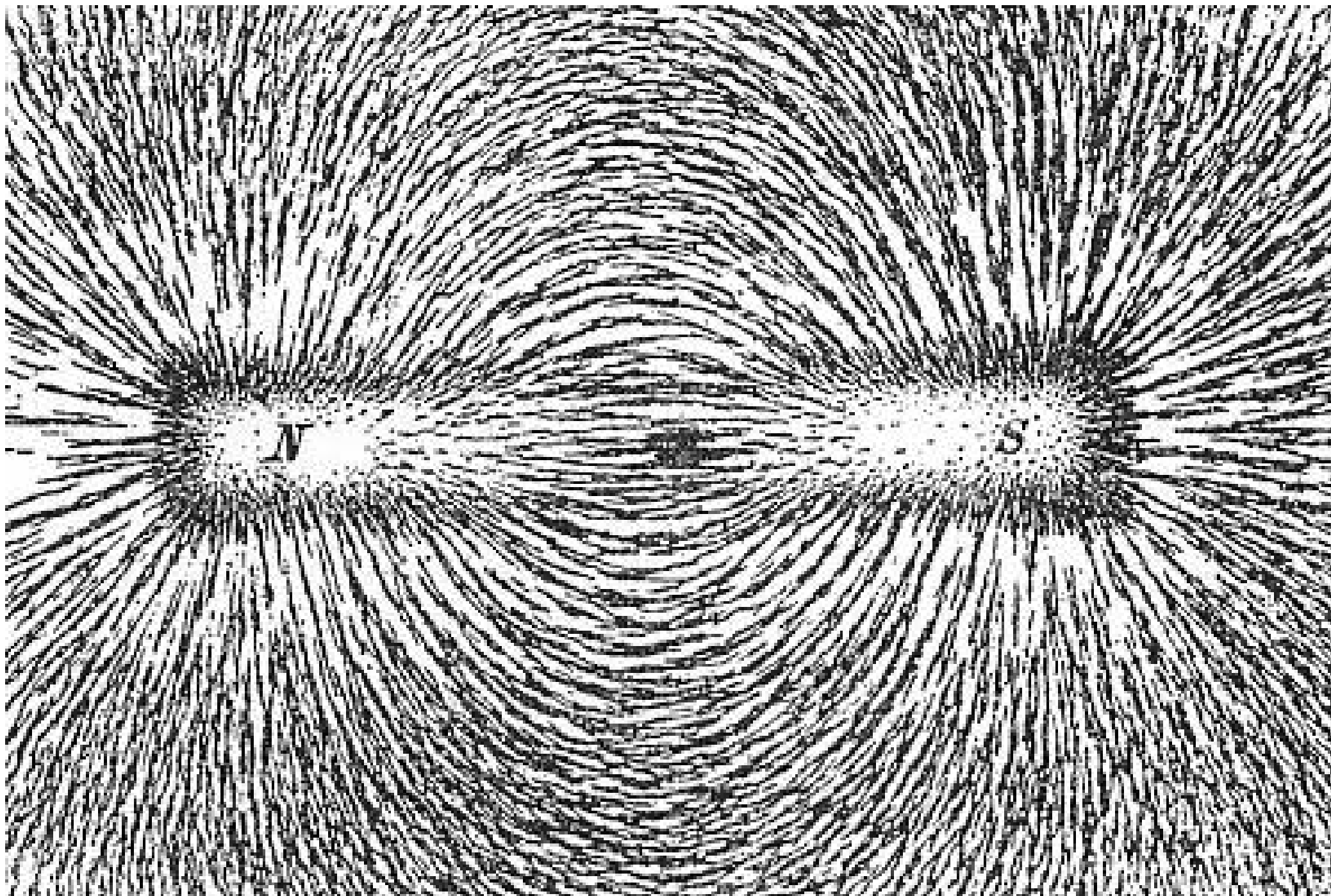
- "Nuclear Era"
 - Yukawa predicts carrier of strong force in 1935 - the "mesons"
 - Muon (mu-meson - *misnomer*): (Anderson, 1936) discovered in cosmic ray radiation. Mistaken for carrier of nuclear force.
 - Pion (pi-meson): (Powell, Lattes, Occhialini, 1947) identified in photographs of cosmic rays
 - Kaon (K-meson): (1947-1953) Required a new quantum property, deemed "strangeness," to explain their contrast to the behavior of pions and protons.

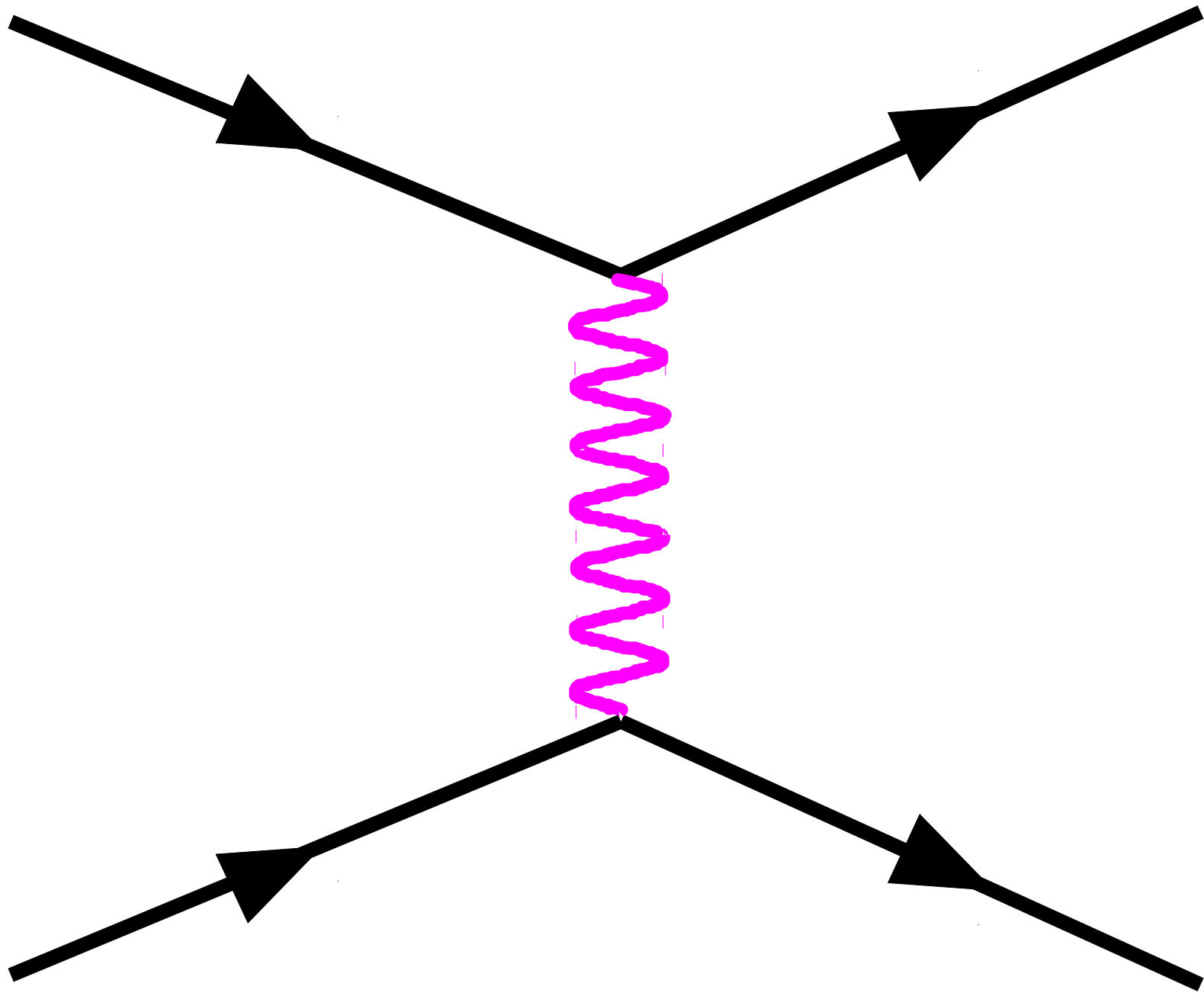


Bubble chamber image
from CERN, c.a. 1970

PARTICLE EXPLOSION

- The Particle Explosion
 - Rho mesons, omega mesons, ...
 - Lambda baryons, sigma baryon, delta baryons, ...
- Many attempts to explain
 - after decades, a winner emerged: the quark hypothesis
 - mesons and baryons can be explained as pairs or triplets of "quarks"
 - Like varying Z and N in a nucleus to change the isotope, varying quark number and type creates the "particle explosion."

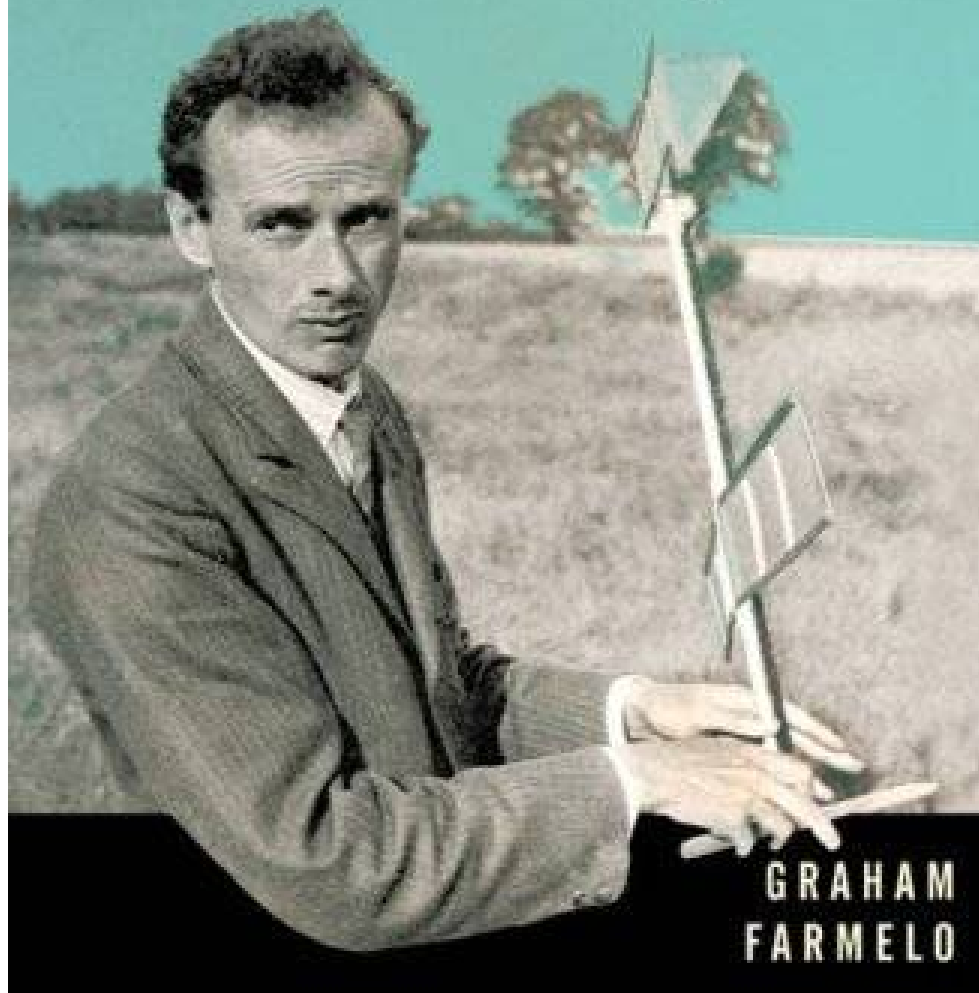




The Strangest Man

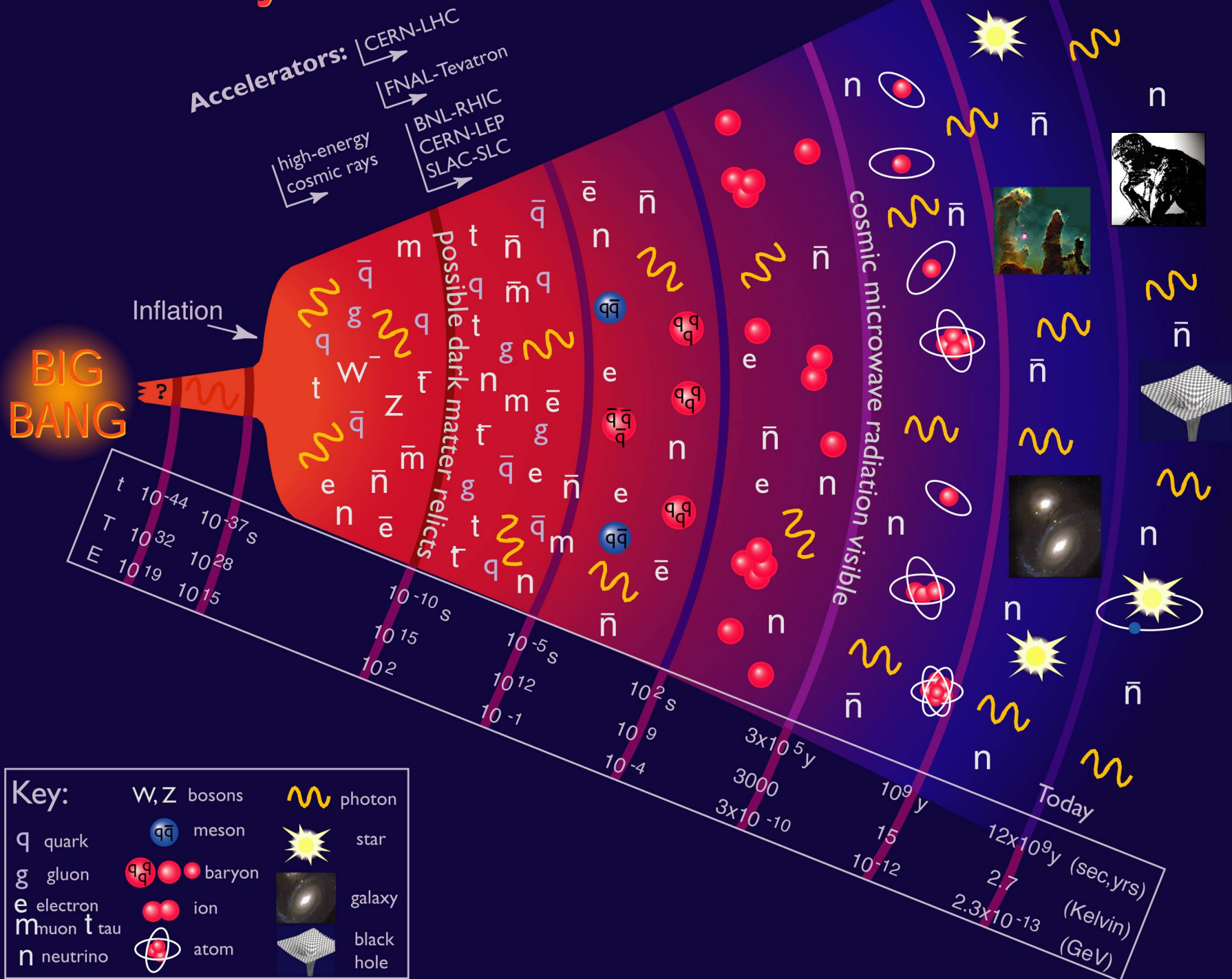
THE HIDDEN LIFE OF PAUL DIRAC,

MYSTIC *of the* ATOM



GRAHAM
FARMELO

History of the Universe

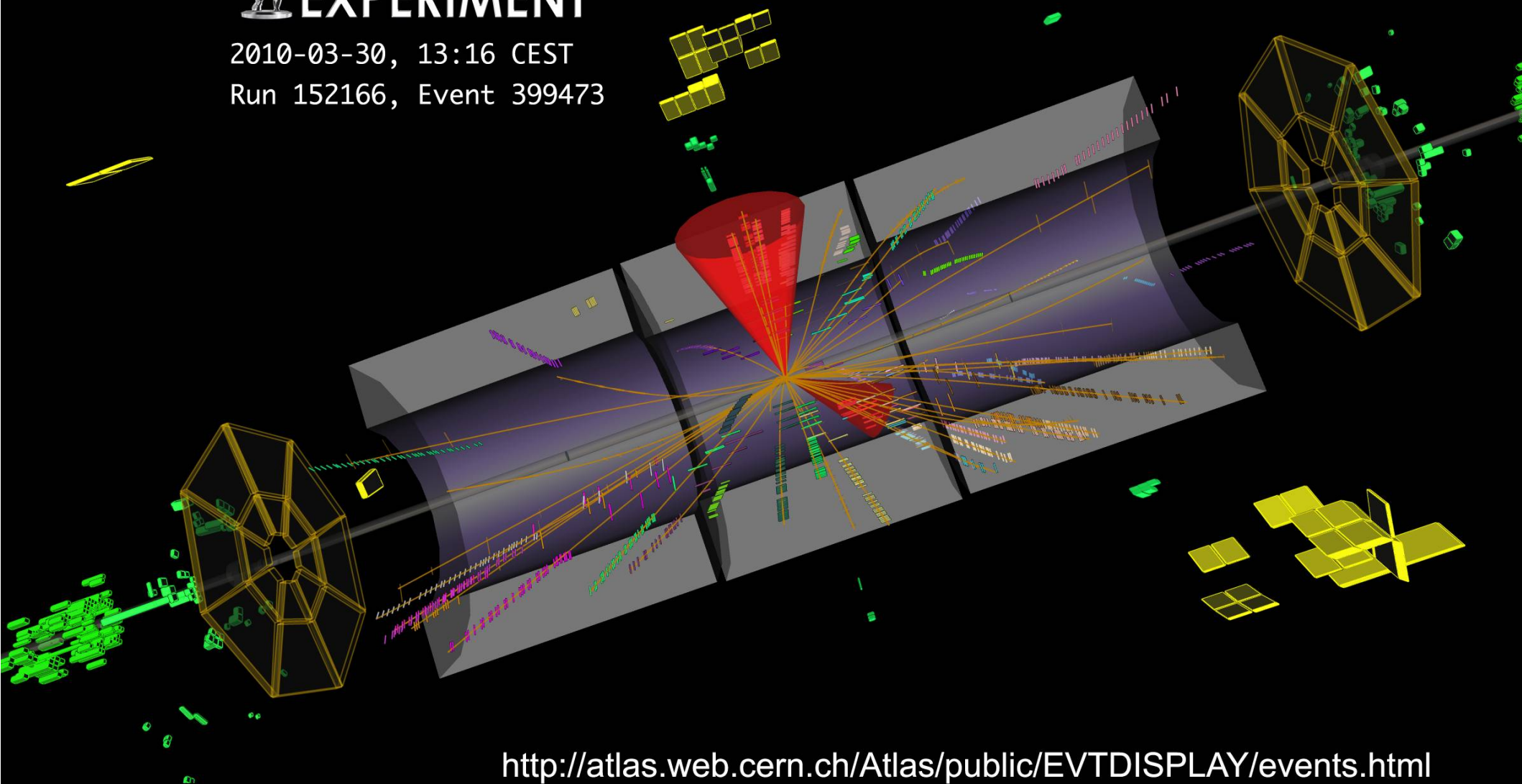




2010-03-30, 13:16 CEST

Run 152166, Event 399473

2-Jet Collision Event at 7 TeV



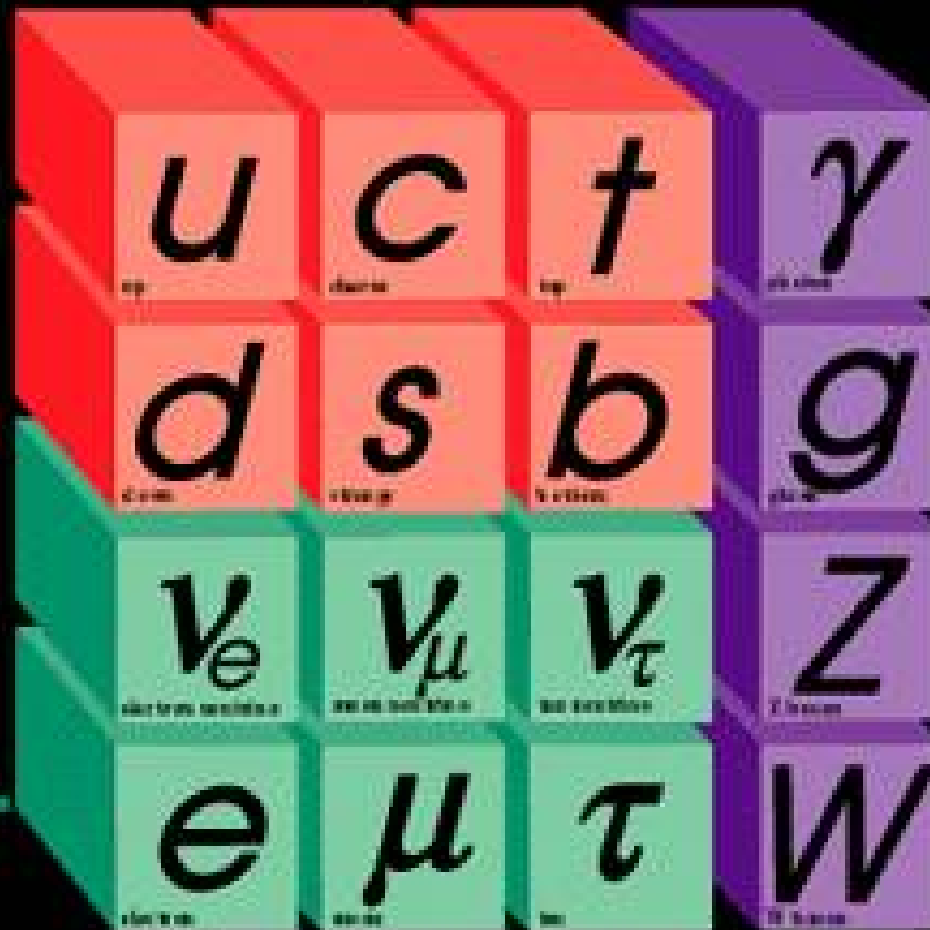
<http://atlas.web.cern.ch/Atlas/public/EVTDISPLAY/events.html>

The Standard Model of Particle Interactions

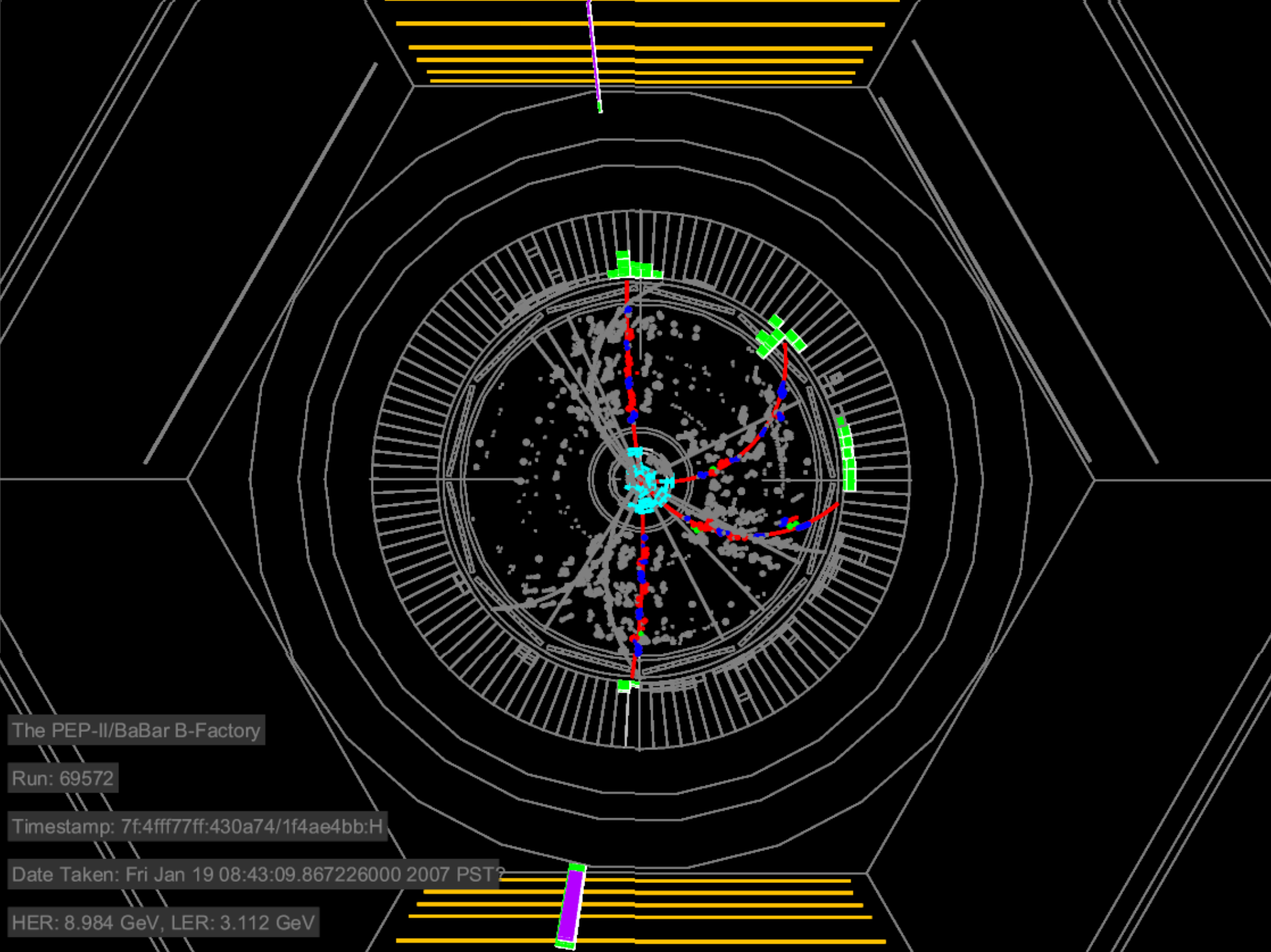
Three Generations of Matter

I II III

Leptons
Quarks



Force Carriers



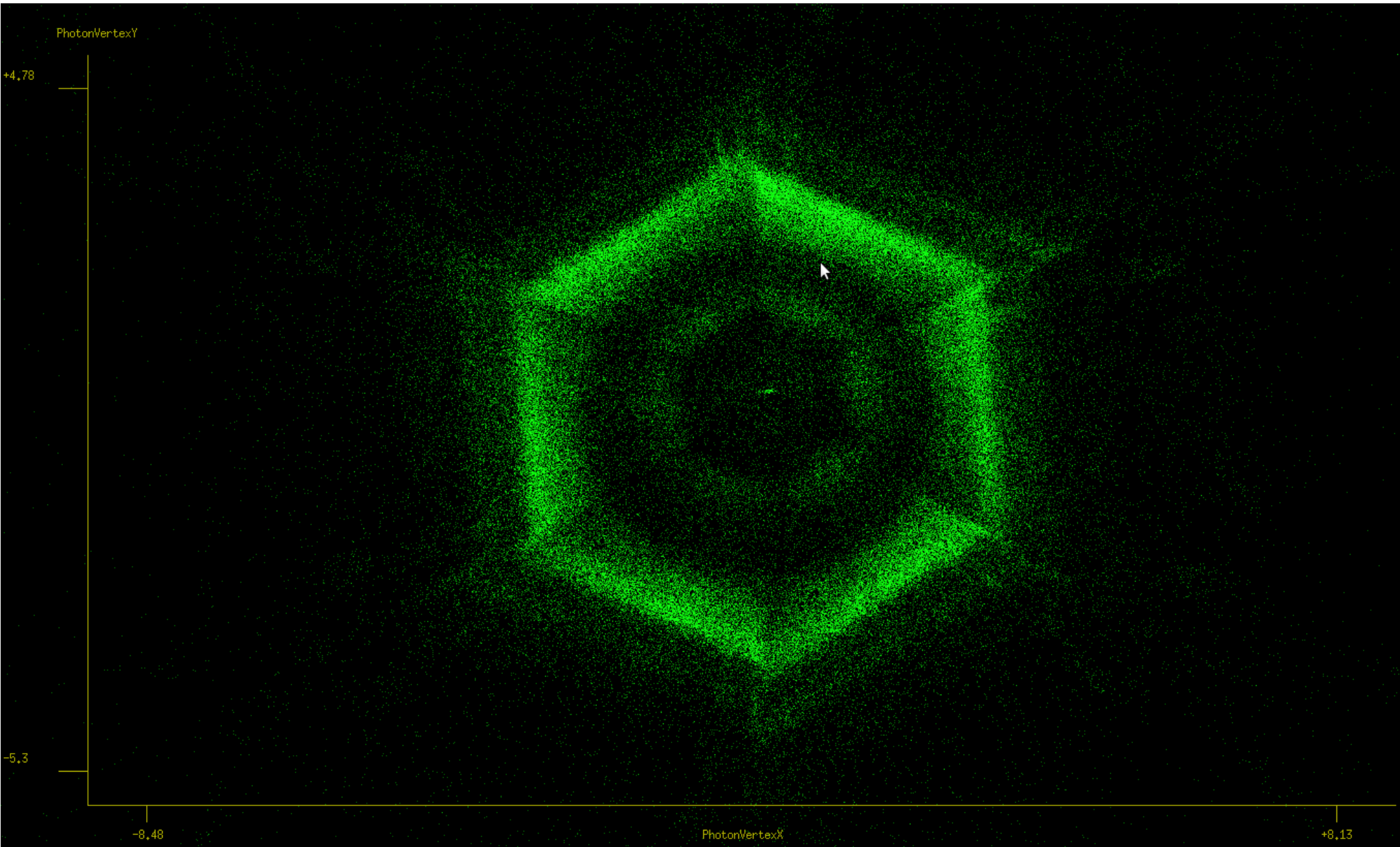
The PEP-II/BaBar B-Factory

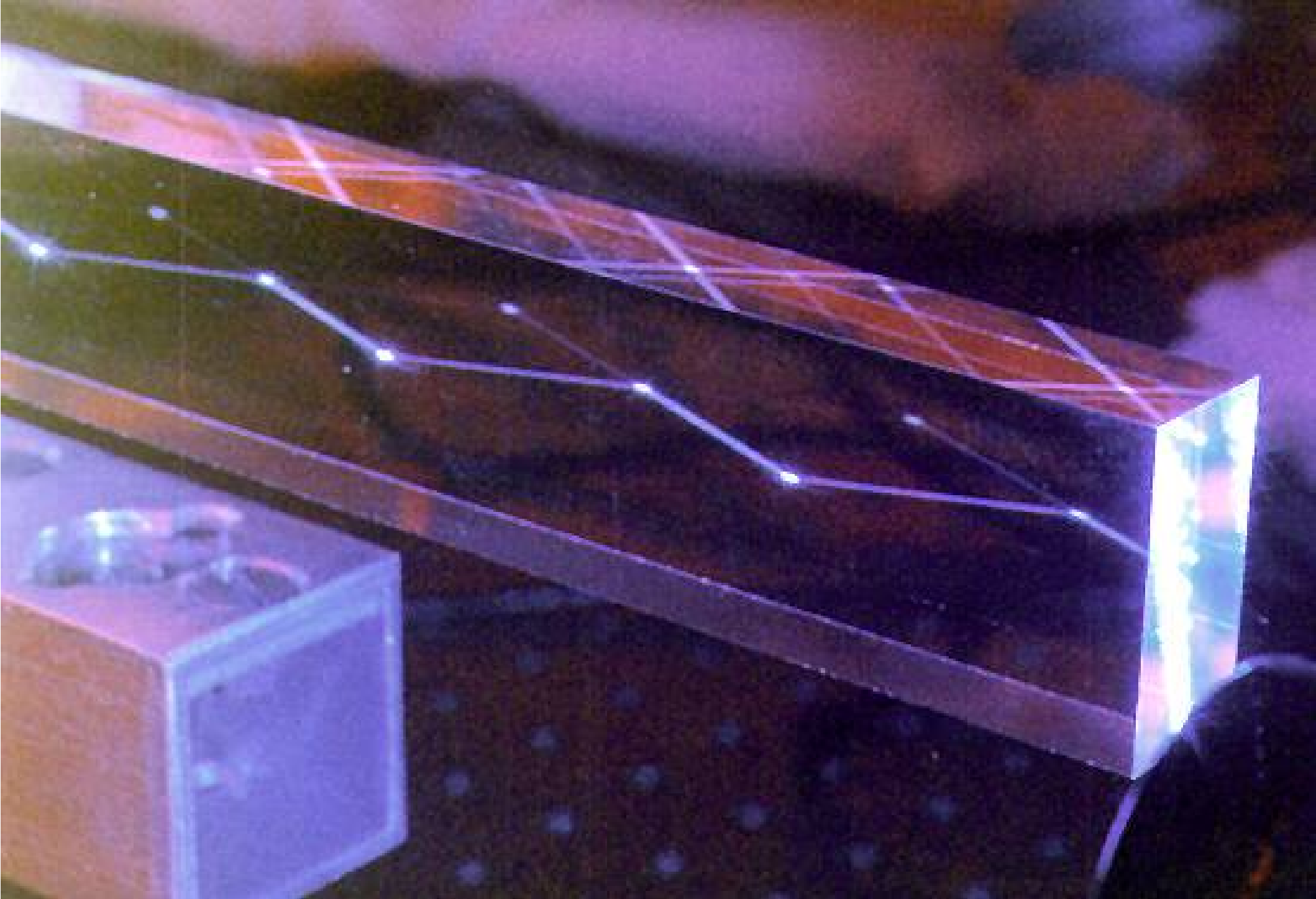
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Timestamp: 7f:4fff77ff:430a74/1f4ae4bb:H

Date Taken: Fri Jan 19 08:43:09.867226000 2007 PST?

HER: 8.984 GeV, LER: 3.112 GeV





NEXT TIME

- Fundamental Particles and Interactions
 - Harris: 12.5-12.7
- In-class presentations all next week
- We have just 2 lecture left
 - the next will be new material
 - the last lecture (Apr. 29) will be a review and discussion of the final exam