Particle Physics for Everyone

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presented by Gordon J. Aubrecht, II

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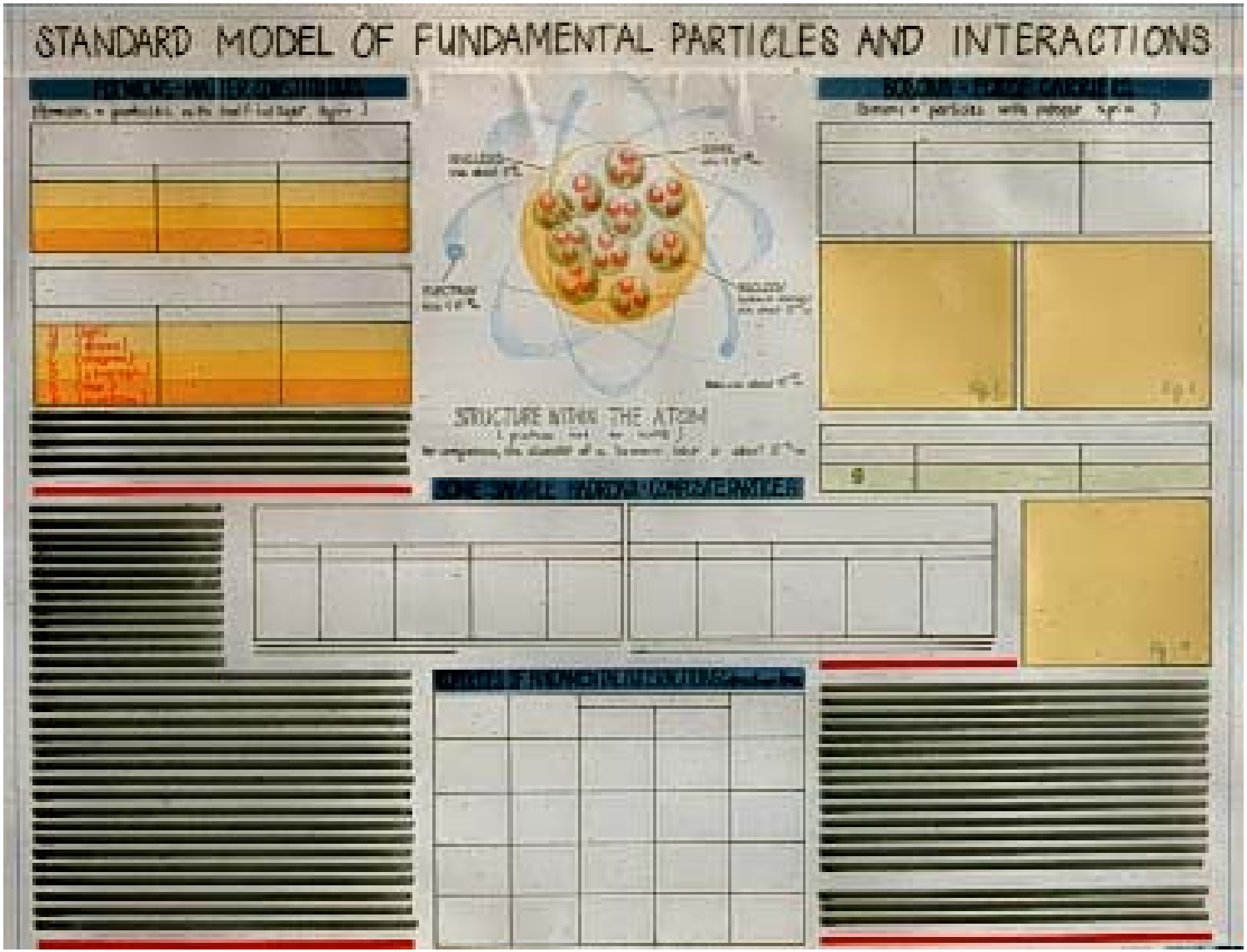
Abstract:
Particle physics has generated intense interest in physics during the past half century. The Contemporary Physics Education Project (CPEP), a volunteer non-profit organization of educators and scientists, has been developing materials to support the introduction of contemporary physics topics into high school and college introductory physics for 20 years. This talk will feature the latest version of the wallchart on the Standard Model of Particles and Interactions as well as supporting activities and materials. Placemat size charts will be distributed to those in attendance. Special emphasis will be given to how the Large Hadron Collider (LHC) at CERN will affect our knowledge of the Standard Model and using the chart to teach about these topics.

The Contemporary Physics Education Project, is known as *CPEP* for short.

CPEP began as a way to bring particle physics into high school (and college) classrooms. At that time, twenty years ago, the Standard Model of particles had jelled into something respectable.

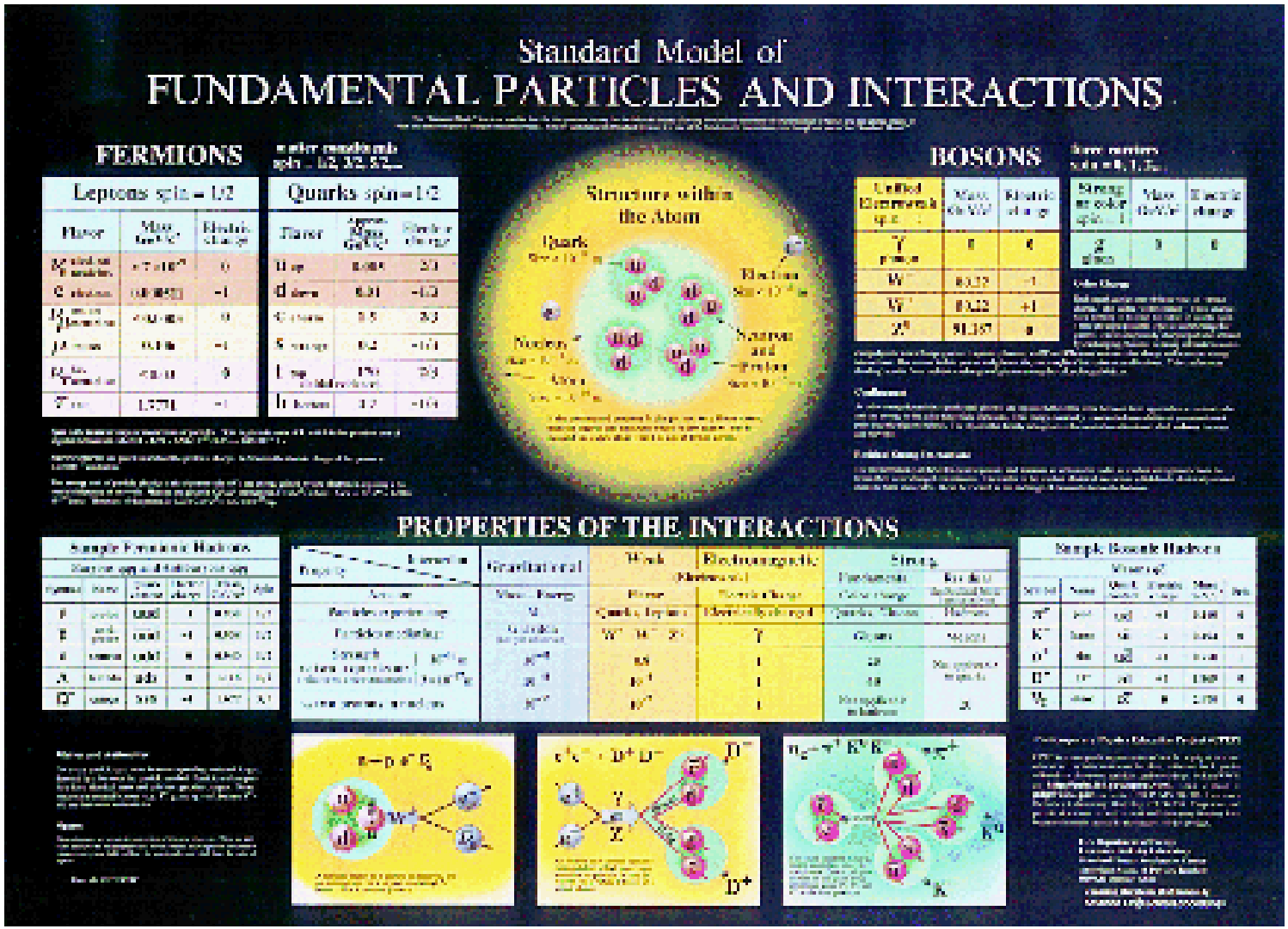
We at *CPEP* thought that presentation of cutting-edge physics and the knowledge that there were still many open questions could lead students to consider future careers as scientists.

This was our original idea.

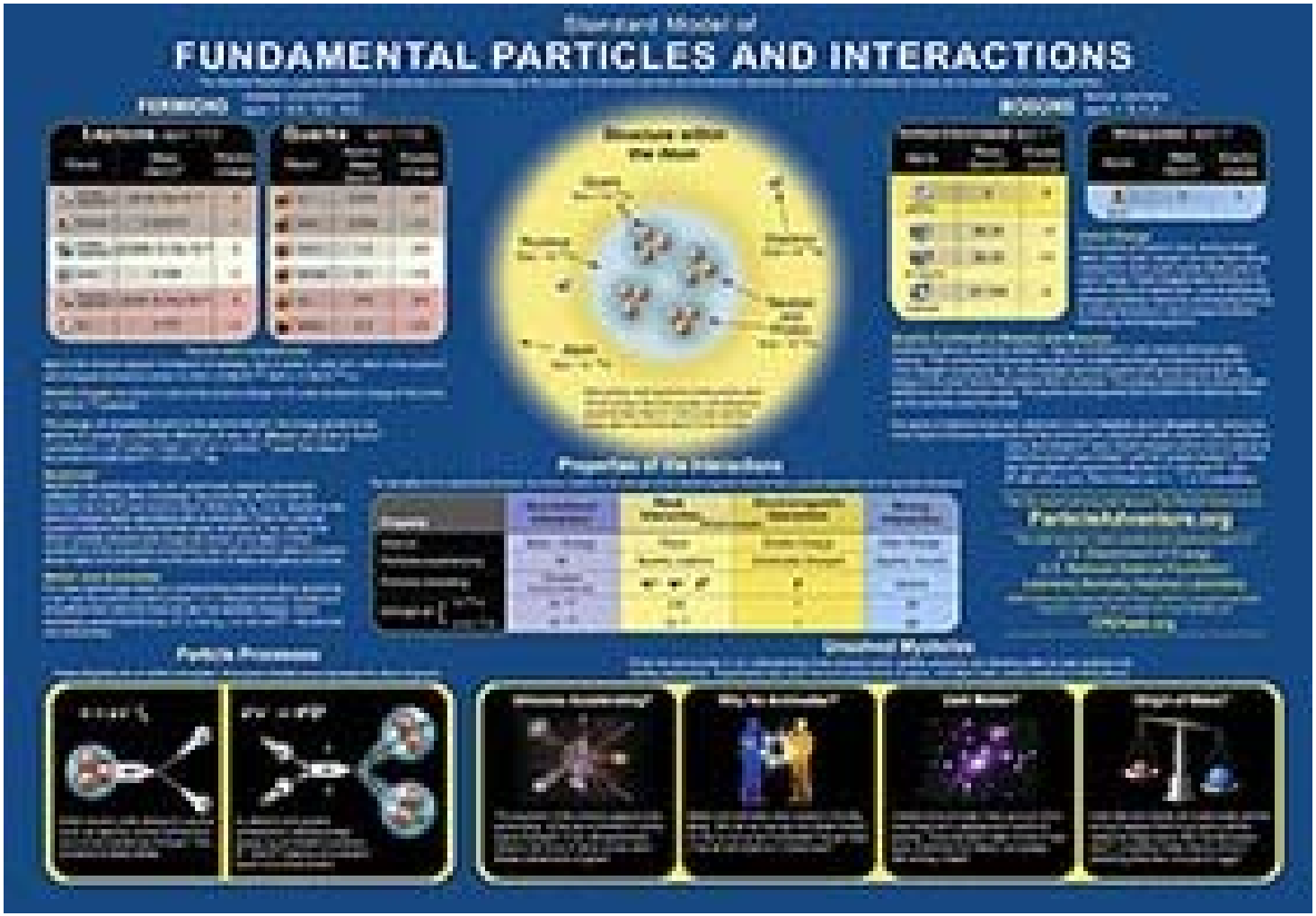


This was how we built on the idea. Notice Gordon had a lot less gray in his hair!

This is the original version of the published chart.



This is the newest version of the particles chart.



There are materials available to help students and teachers as well. *CPEP* thought that we needed to assist serious study as well as providing visual beauty and provoking curiosity through charts.

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Amazon.com: *The Charm of Strange Quarks: Mysteries and Revolutions of Particle Physics*: R Michael Barnett, Henry Muehry, Helen R. Quinn, G. J. Aubrecht, ...
www.amazon.com/Charm-Strange-Quarks-Mysteries-Revolutions/dp/0387988971 - 307k -

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I′m writing this ahead of time, so I don′t quite know how we′ll manage it here, but we have ~120 copies of current *CPEP* particle charts, and I hope each of you will be able to take one home with you.

I do want to let you know that the all the *CPEP* charts are available in two larger sizes:
a poster size chart (0.75 m x 0.50 m)
and a full size chart (1.5 m x 1 m)

How can the charts be used?

Well, of course, first as an arresting element in the classroom to attract attention when idle minds wander ...

The charts are also an entryway into the web-based support system.


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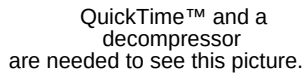
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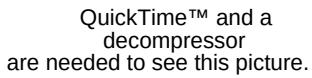
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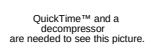
As you can see, there is a great deal of information available backing up our charts that can be used by both teachers and students. In addition, as we saw for particles, kits are available from Science Kit that support teaching with the charts and ancillary other materials.

Let's use an example. When forces are introduced in many physics courses, they are mysterious. Where does the force come from? Actually, forces are really *interactions*, and involve two bodies or agents. This is usually first seen–and misunderstood–in discussions of Newton's Third Law. How does *CPEP* help?

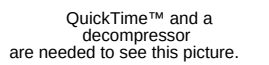
The forces are introduced as *interactions* from the first: gravitational interaction, electroweak interaction, strong interaction. We show on what the interaction works, and introduce the idea of exchange of particles as responsible (emphasizing the two elements). Finally, we provide an assessment of relative strength.



So, we prepare students to think of *interactions* between particles as *fundamental*—a basic physics concept that is in the context of current physics research!

The Large Hadron Collider (LHC) is a place where interactions can occur. The Higgs particle may soon be discovered there.

CERN's LHC will allow us to glimpse interactions at really high energy. Michael Barnett is a member of Atlas, which is one of the detectors at the LHC.

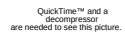


The LHC is a circular accelerator ring 27 km around. Particles are steered in both directions using superconducting magnets and made to collide in several regions loaded with detectors like the Atlas detector.

Because the ring is so big, the particles' energies are immense–10 TeV–and the particles are traveling at essentially the speed of light: $E = \gamma\, mc^2 = \gamma\ 1\ \text{GeV}$, so

$\gamma = 10\ \text{TeV}/(1\ \text{GeV}) = 10{,}000$, giving

$v = c - 1.5\ \text{m/s}$.



LHC preaccelerators

p and Pb: Linear accelerators for protons (Linac 2) and Lead (Linac 3)

(not marked) Proton Synchrotron Booster

PS: Proton Synchrotron SPS: Super Proton Synchrotron

LHC experiments

ATLAS	A Toroidal LHC Apparatus
CMS	Compact Muon Solenoid
LHCb	LHC-beauty
ALICE	A Large Ion Collider Experiment
TOTEM	Total Cross Section, Elastic Scattering and Diffraction Dissociation
LHCf	LHC-forward

ATLAS is about 45 meters long, more than 25 meters high, and has a mass of about 7,000 tonnes.

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decompressor
are needed to see this picture.

I hope this talk has given you food for thought. Other colleagues from *CPEP* will be presenting other aspects of our charts and particles. I hope you were here earlier for IE04, "Particle physics through cosmology."

I urge you to stay for papers IE08, "Teaching the history of nuclear science with the CPEP wallchart," and IE09, "Particle physics through fusion," and to visit the poster PST1-09, "Fusion and particles in the classroom." *CPEP* offers many ways to support teaching contemporary physics.

- http://www.youtube.com/watch?v=j50ZssEojtM

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