Getting Particle Physics into the High School Classroom

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Modern physics in secondary schools

- Special relativity
- Quantum physics
- Particle physics
- Astronomy
- cosmology

Fitting the Curriculum

- If possible, hands-on (experiments)
- Cheap, accessible materials
- Process of science
- Test with students --- and iterate.

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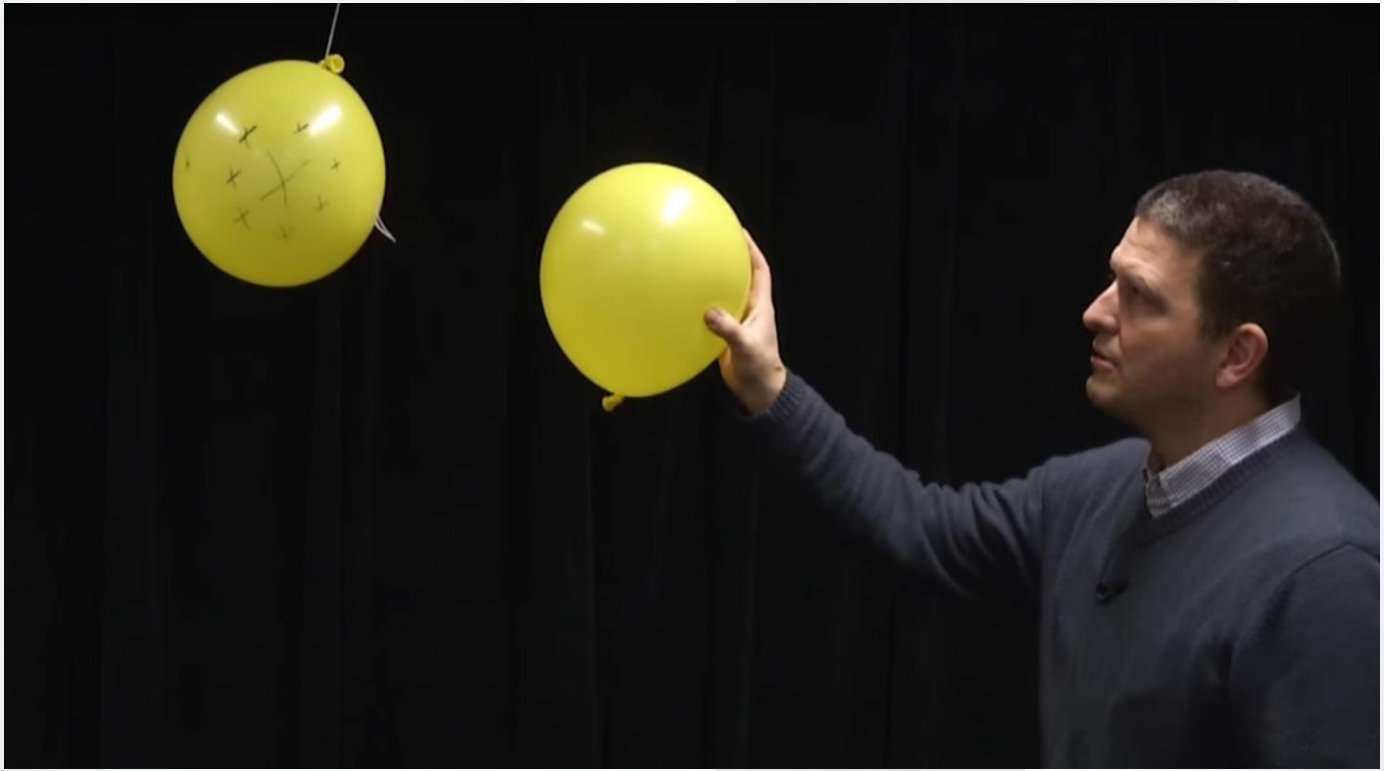
Rutherford Scattering



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Particle Zoo Cards

p **PROTON** **mass:** 938 MeV spin-$\frac{1}{2}$ $Q = +1$ $S = 0$ **discovered:** 1919	Σ^{*-} **SIGMA STAR MINUS** **mass:** 1387 MeV spin-$\frac{3}{2}$ $Q = -1$ $S = -1$ **discovered:** 1960	π^0 **PION (PI ZERO)** **mass:** 135 MeV spin-0 $Q = 0$ $S = 0$ **discovered:** 1949
Δ^- **DELTA MINUS** **mass:** 1232 MeV spin-$\frac{3}{2}$ $Q = -1$ $S = 0$ **discovered:** 1954	Ξ^0 **XI ZERO** **mass:** 1315 MeV spin-$\frac{1}{2}$ $Q = 0$ $S = -2$ **discovered:** 1959	Ξ^{*-} **XI STAR MINUS** **mass:** 1535 MeV spin-$\frac{3}{2}$ $Q = -1$ $S = -2$ **discovered:** 1962
Σ^- **SIGMA MINUS** **mass:** 1197 MeV spin-$\frac{1}{2}$ $Q = -1$ $S = -1$ **discovered:** 1953	K^0 **KAON (K ZERO)** **mass:** 498 MeV spin-0 $Q = 0$ $S = +1$ **discovered:** 1947	π^+ **PION (PI PLUS)** **mass:** 140 MeV spin-0 $Q = +1$ $S = 0$ **discovered:** 1947
Ξ^{*0} **XI STAR ZERO** **mass:** 1532 MeV spin-$\frac{3}{2}$ $Q = 0$ $S = -2$ **discovered:** 1962	Σ^0 **SIGMA ZERO** **mass:** 1193 MeV spin-$\frac{1}{2}$ $Q = 0$ $S = -1$ **discovered:** 1956	n **NEUTRON** **mass:** 940 MeV spin-$\frac{1}{2}$ $Q = 0$ $S = 0$ **discovered:** 1932
Σ^+ **SIGMA PLUS** **mass:** 1189 MeV spin-$\frac{1}{2}$ $Q = +1$ $S = -1$ **discovered:** 1953	K^- **KAON (K MINUS)** **mass:** 494 MeV spin-0 $Q = -1$ $S = -1$ **discovered:** 1947	η **ETA** **mass:** 548 MeV spin-0 $Q = 0$ $S = 0$ **discovered:** 1961

Bubble Chamber Physics

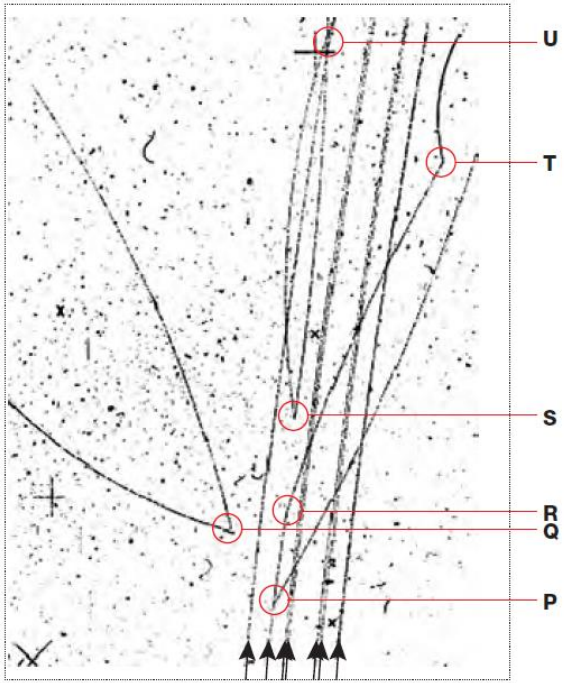

Figure 1 Photograph of CERN bubble chamber. Arrows indicate kaons moving up the page. There is a constant magnetic field into the page.

$$F_M = qvB$$

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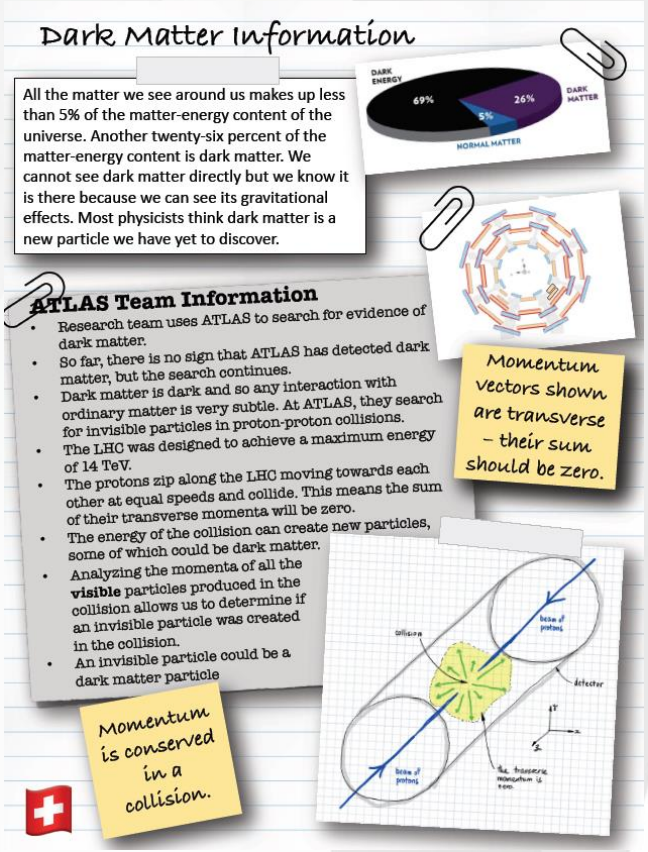
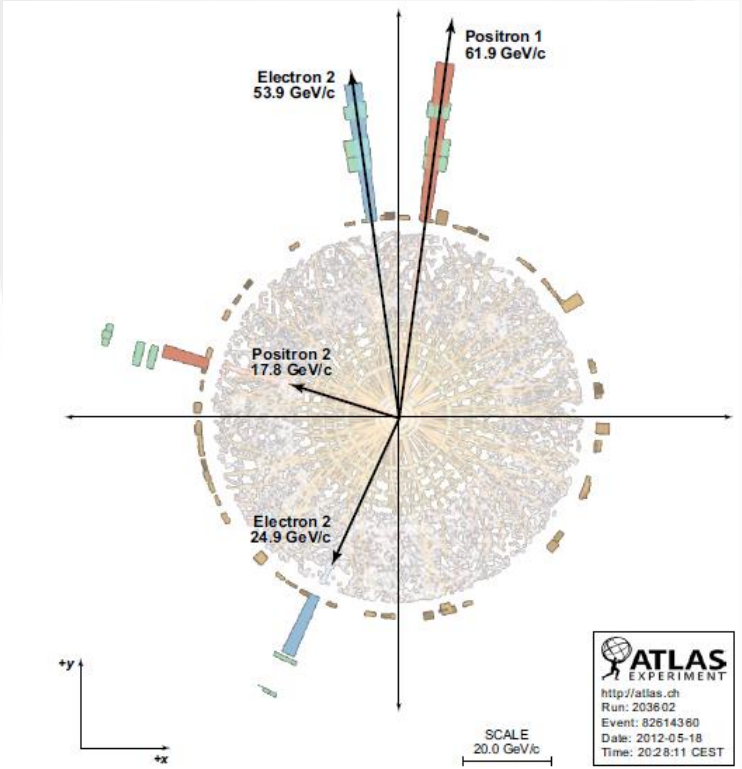
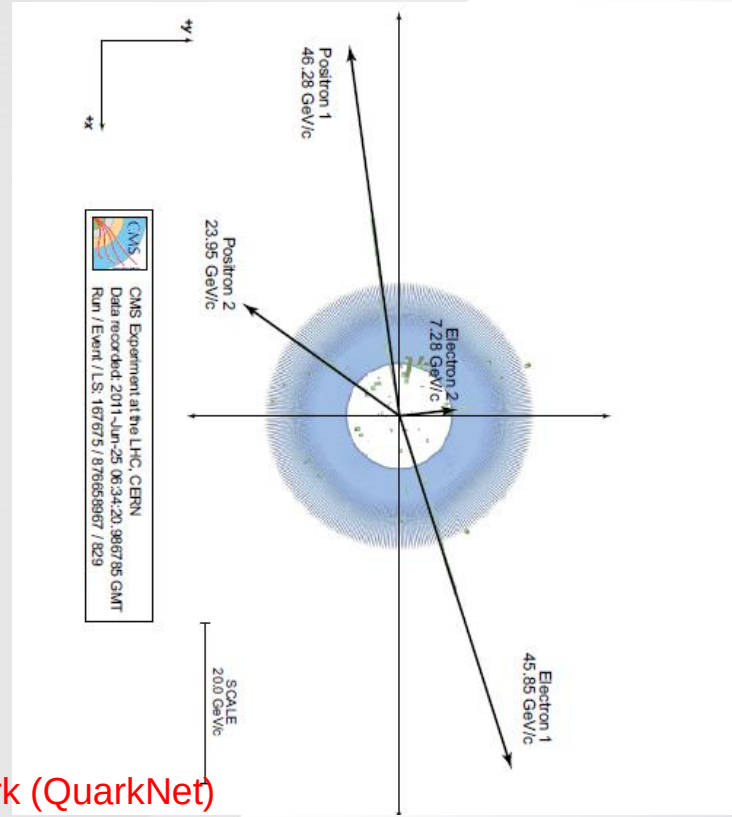
Particle physics virtual escape room



Mass of Higgs boson



ATLAS data for the possible decay of a Higgs boson into two electrons and two positrons. The rectangular shapes on the outside of the circle represent measured energy of each particle. Note the *x*- and *y*-axes.



Mass of Top Quark (QuarkNet)
CERN'S Masterclass (Z path)

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- Conservation of momentum & energy

$$E^2 = (pc)^2 + (mc^2)^2$$

FREE Resources

https://resources.perimeterinstitute.ca/

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