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WHERE DISCOVERIES BEGIN

Supersymmetry, Dark Matter, and Cosmology in Collider Experiments

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Dark Matter

- There are still many mysteries in physics
- The observed rate of galaxy rotation does not match predicted values
- The remnants of a galaxy collision suggest unseen heavy particles

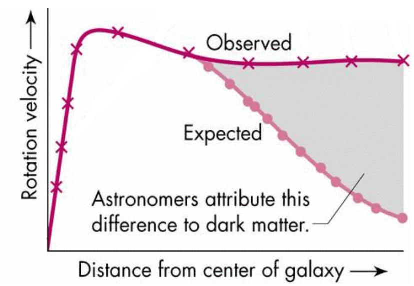

Figure 1. A graph of galaxy rotation vs. distance from the center. The observed velocities are much higher than the expected ones.

Figure 2. The recently observed remnants of a galactic collision. The red is matter that can be seen, such as stars and gas. The blue is "missing mass," dark matter.

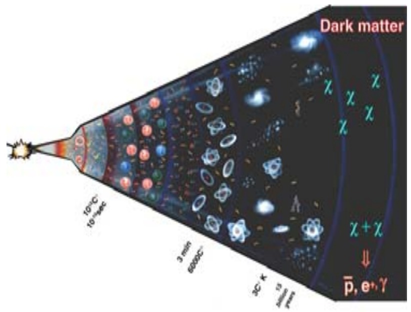

Figure 3. A diagram of the evolution of the universe where SUSY plays a role. Perhaps dark matter is a sparticle, χ?

Supersymmetry (SUSY)

- Particles have very massive super-partners called sparticles
- The lightest SUSY particle (LSP) may be a candidate for dark matter
- Simple model - the other particles quickly decayed into the LSP in the early universe and are still around today as dark matter
- *Possible explanation for dark matter with the ability to describe the early universe*
- *May link astronomy, cosmology, and particle physics*

Searching for SUSY

- The Tevatron Collider at Fermilab in Chicago is the most powerful collider until the Large Hadron Collider begins working
- It collides protons and antiprotons, recreating conditions after the big bang
- Detectors such as the Collider Detector at Fermilab (CDF) are set up at beam collision sites to search for sparticles

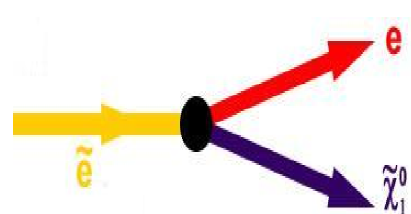

Figure 4. The decay of a sparticle to the LSP and an electron in the early universe.

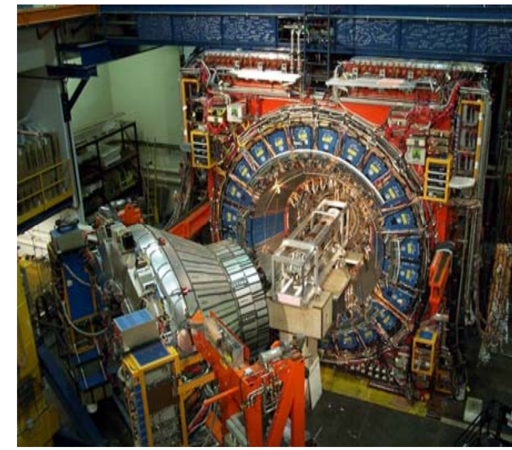

Figure 5. An image of the Collider Detector at Fermilab, a project at the Tevatron. It is about three stories tall.

Conclusion

- No sparticles observed in detector
- Current data is used to establish lower bounds on SUSY
- Perhaps SUSY is a correct description of nature but has nothing to do with dark matter
- Maybe the higher energies of the Large Hadron Collider are needed to make sparticles
- Exciting possibilities for major breakthroughs lie just beyond the corner