Dark Matter – A Particle Physicist's Perspective

Matthew Kirk – Physics, PhD
Why do we need dark matter?

• First mentioned in 1930

• Swiss astronomer – Fritz Zwicky

• Used virial theorem to calculate mass of galaxy
Why do we need dark matter?

- First mentioned in 1930
- Swiss astronomer – Fritz Zwicky
- Used virial theorem to calculate mass of galaxy
- Factor of 500 different to expected result
Why do we need dark matter?

- Rotation curves – how fast stars orbit depends on how far out they are
- First accurate measurement by Vera Rubin – 1970s
- Should fall off – but instead to flatten out
Why do we need dark matter?
Why do we need dark matter?

- Gravitational lensing
  - Similar idea as virial theorem
  - Gravity bends light passing near galaxy – how much depends on how heavy the galaxy is
  - Get a difference between what is seen and the amount calculated
What do we know?

- Cosmic Microwave Background – Plank and WMAP
- Dark Matter is around 26% of universe
What else have we seen?

- Excess of photons from the centre of the galaxy
What else have we seen?

- Excess of photons from the centre of the galaxy
- Excess of antiprotons compared to protons
What else have we seen?

- Excess of photons from the centre of the galaxy
- Excess of antiprotons compared to protons
- Excess of positrons
What haven't we seen?

- Any “real” evidence down here on Earth!
What haven't we seen?

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- Direct detection limits keep on going down
What haven't we seen?

- Any “real” evidence down here on Earth!
- Direct detection limits keep on going down
- Except something odd perhaps in
  - DAMA
  - CoGeNT
  - CDMS
DAMA/NaI (0.29 ton yr)  
(target mass = 87.3 kg)  

DAMA/LIBRA (0.53 ton yr)  
(target mass = 232.8 kg)  

Time (day)
What am I doing?
What am I doing?

- Looking at simplified models
  - Single dark matter particle, single mediator particle
What am I doing?

• Expect “new physics” to affect lots of “old physics”

• What we haven't seen can be just as useful as what we have
Thanks!
Backup slides
What else have we seen?

- Excess of photons from the centre of the galaxy
- Excess of antiprotons compared to protons
- Excess of positrons
- Hints of self interaction between dark matter particles?