

Synergistic Activities

- For various historical and programmatic reasons, the Theoretical Astrophysics Group at Fermilab is exceptionally focused on questions of “fundamental physics” and connections with particle physics, and closely connected with the experimental astrophysics program
- Regular interactions between particle theory and astro theory groups, and between astro theory and experimental groups — has produced many papers with mixed authorship
- Mutual attendance at astrophysics and particle theory seminars, journal clubs (including the recent “Axion club”, involving theorists and experimentalists)

Theory/Experiment/Particle/Astro Synergy

(Galactic Center Case Example)

Early Theory Work:

**Extracting the Gamma Ray Signal from Dark Matter
Annihilation in the Galactic Center Region (2007)**

[Dodelson, Hooper, Serpico]



Early Data Analysis:

**Possible Evidence For Dark Matter Annihilation In The Inner Milky
Way From The Fermi Gamma Ray Space Telescope (2009)**
**Dark Matter Annihilation in The Galactic Center As Seen by the
Fermi Gamma Ray Space Telescope (2010)**
On The Origin Of The Gamma Rays From The Galactic Center (2011)

[Hooper, Goodenough, Linden]



More Sophisticated Data Analysis:

**The Characterization of the Gamma-Ray Signal from the Central
Milky Way: A Compelling Case for Annihilating Dark Matter (2014)**
Background model systematics for the Fermi GeV excess (2014)

[Hooper, Linden, et al.]

Theory/Experiment/Particle/Astro Synergy (Case Example)

Early Theory Work:
Extracting the Gamma Ray Signal from Dark Matter
Annihilation in the Galactic Center Region (2007)
[Dodelson, Hooper, Serpico]

**Analysis by
Other Groups:**
UC Irvine, Canterbury, Fermi

**Connections With
High-Energy
Astrophysics:**
Dozens of papers from many
institutions on possible backgrounds
and complementary probes, including
millisecond pulsars and cosmic ray
and radio astrophysics

Early Data Analysis:
Possible Evidence For Dark Matter Annihilation In The Inner Milky
Way From The Fermi Gamma Ray Space Telescope (2009)
Dark Matter Annihilation in The Galactic Center As Seen by the
Fermi Gamma Ray Space Telescope (2010)
On The Origin Of The Gamma Rays From The Galactic Center (2011)
[Hooper, Goodenough, Linden]

Particle Theory Papers:
Numerous papers, including 15 by Fermilab Scientists
[Agrawal, Batell, Berlin, Buckley, Cholis,
DiFranzo, Fox, Harnick, Hooper, Kopp,
McDermott, Yu, etc.]

More Sophisticated Data Analysis:
The Characterization of the Gamma-Ray Signal from the Central
Milky Way: A Compelling Case for Annihilating Dark Matter (2014)
Background model systematics for the Fermi GeV excess (2014)
[Hooper, Linden, et al.]

**Motivation and Implications for
Other Search Strategies:**
ATLAS mono-b, LEP, PAMELA, AMS, Fermi dwarfs, Fermi
IGRB, numerous direct detection experiments, etc.

Theory/Experiment/Particle/Astro Synergy (Case Example)

Early Theory Work:
Extracting the Gamma Ray Signal from Dark Matter
Annihilation in the Galactic Center Region (2007)
[Dodelson, Hooper, **Serpico**]

**Analysis by
Other Groups:**
UC Irvine, Canterbury, Fermi

**Connections With
High-Energy
Astrophysics:**
Dozens of papers from many
institutions on possible backgrounds
and complementary probes, including
millisecond pulsars and cosmic ray
and radio astrophysics

Early Data Analysis:
Possible Evidence For Dark Matter Annihilation In The Inner Milky
Way From The Fermi Gamma Ray Space Telescope (2009)
Dark Matter Annihilation in The Galactic Center As Seen by the
Fermi Gamma Ray Space Telescope (2010)
On The Origin Of The Gamma Rays From The Galactic Center (2011)
[Hooper, **Goodenough**, **Linden**]

Particle Theory Papers:
Numerous papers, including 15 by Fermilab Scientists
[**Agrawal**, **Batell**, **Berlin**, **Buckley**, **Cholis**,
DiFranzo, Fox, Harnick, Hooper, **Kopp**,
McDermott, **Yu**, etc.]

More Sophisticated Data Analysis:
The Characterization of the Gamma-Ray Signal from the Central
Milky Way: A Compelling Case for Annihilating Dark Matter (2014)
Background model systematics for the Fermi GeV excess (2014)
[Hooper, **Linden**, et al.]

**Motivation and Implications for
Other Search Strategies:**
ATLAS mono-b, LEP, PAMELA, AMS, Fermi dwarfs, Fermi
IGRB, numerous direct detection experiments, etc.