

Fermi in Context

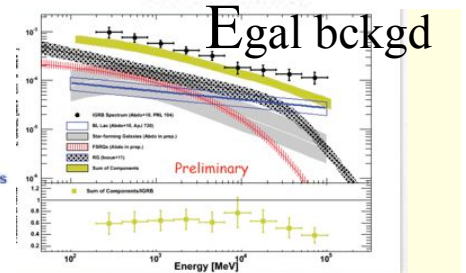
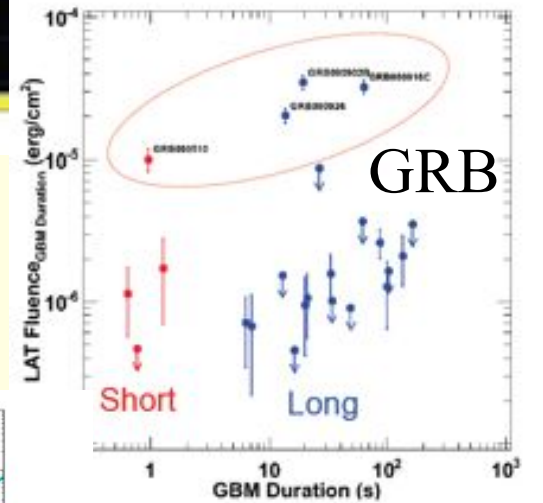
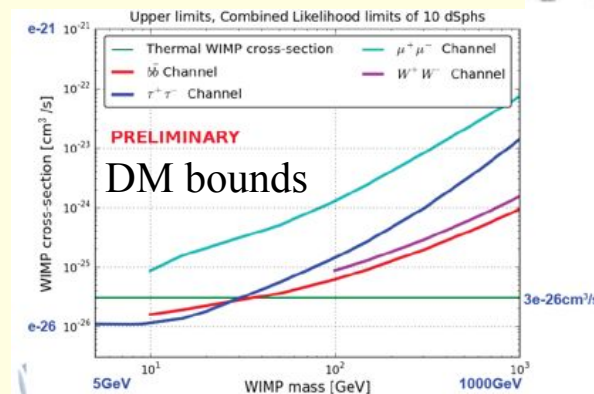
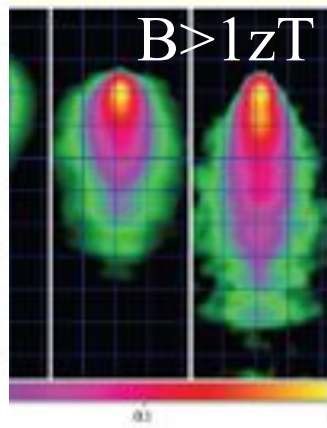
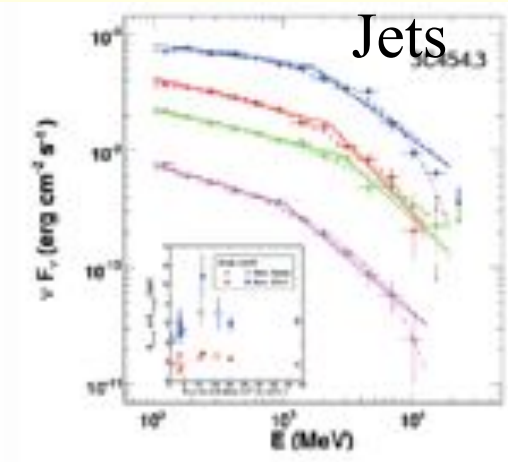
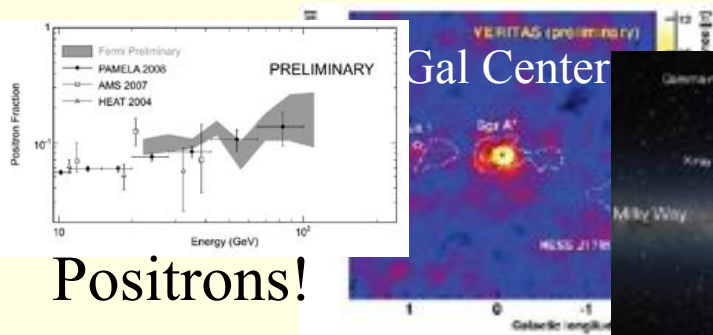
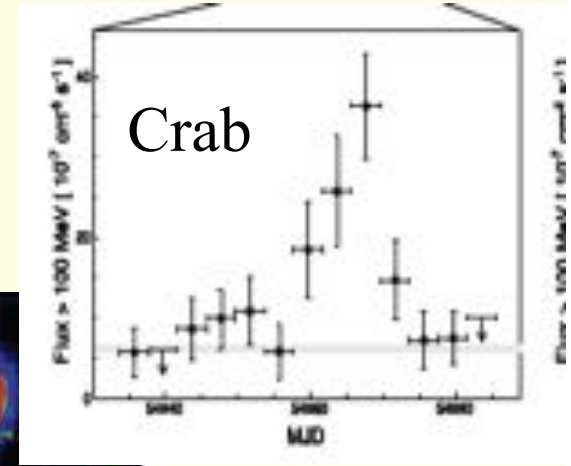
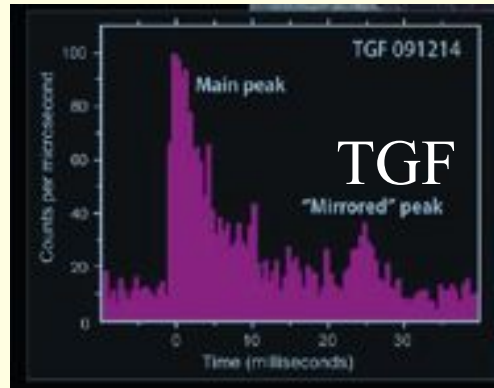
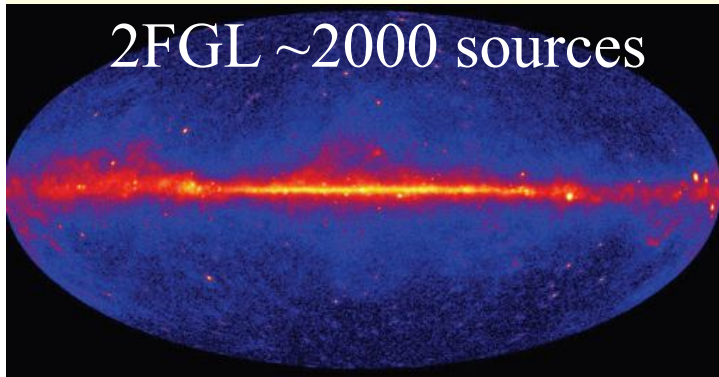


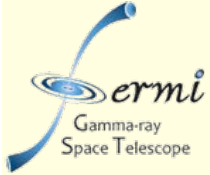
Roger Blandford
KIPAC
Stanford

Mirabel 2006

Summary and Parting Questions from Rome

(Steve Ritz)





What have you done for us lately?

- **Major NASA, DOE National Reviews**
 - **Fermi team acquitted itself well**
 - **Competitive environment; tough budgets**
- **Maintain rate of discovery to justify the ten year mission**
 - **Reap harvest from PASS 8 etc**
 - **Overlap upcoming telescopes**
- **This meeting will keep us on schedule**
 - **Major announcements forthcoming**
- **Discovery/understanding more fun than upper limits!**
 - **Exoplanets!**
 - **“Higgs-like particle”**
- **Five possibilities for major discoveries that could involve Fermi**
 - **Engage and connect with other fields**

What will you have done for us lately?

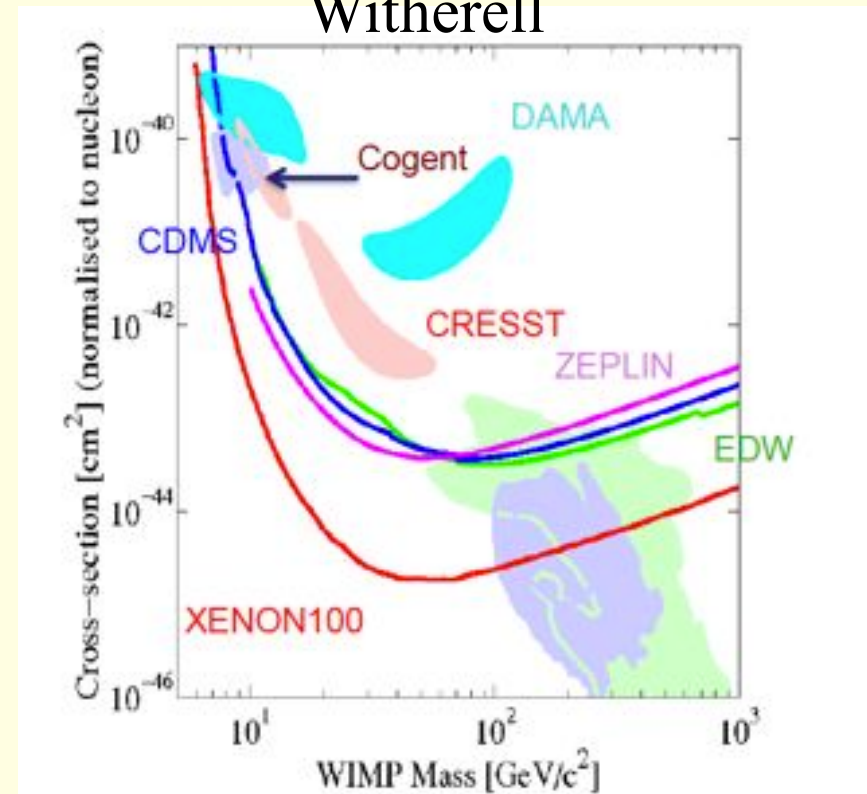
Dark Matter

- **23 percent of contemporary universe**
- **WIMP- neutral stable particle once in thermal equilibrium**
 - **WIMP miracle: $m \sim 100 \text{ GeV}$; $\langle \sigma v \rangle \sim 3 \times 10^{-26} \text{ cm}^3 \text{ s}^{-1}$**
 - **Neutralino – lightest supersymmetric particle; fermionic photon?**
 - **Fermions \leftrightarrow Bosons**
 - **Strongly motivated, EW symmetry breaking by Higgs; 10YeV unification**
 - **Strong lines not excluded but generally unexpected**
 - **Only a theory; many other possibilities...**
 - **Axions, Wimpzillas, gravitinos...**
- **ATLAS, CMS expected to find from missing transverse energy**
 - **Not seen yet; ≥ 24 parameters, only simplest version excluded**
 - **Reports of demise of SUSY are greatly exaggerated!**
 - **Higher and lower mass particles “natural”?**
- **May find at $< 13 \text{ TeV}$ energy or with Higgs factory- e^+e^- collider**
 - **Not soon!**

Direct Detection

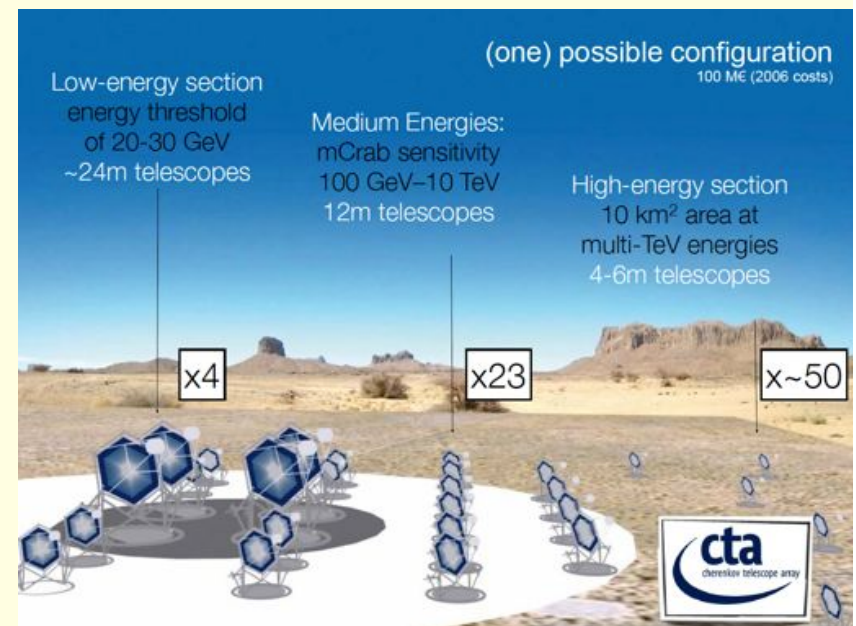
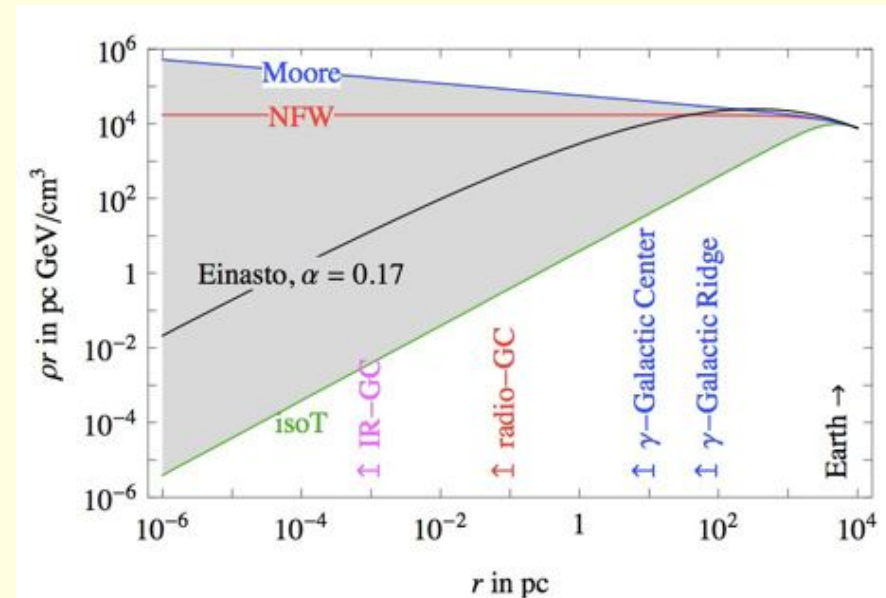
- **30 experiments**
 - Crystals, Xe, Ar, Bubbles....
 - Backgrounds are key
 - Shield or veto
- **Sensitivity increased by 10^{-4}**
 - Goal is 10^{-6}
 - >5 t detectors proposed
 - Solar neutrino limit?
- **No confirmed detections**
 - DAMA annual signal is 9σ !
- **International downselect likely**
 - 5 t detector could overlap Fermi

Witherell



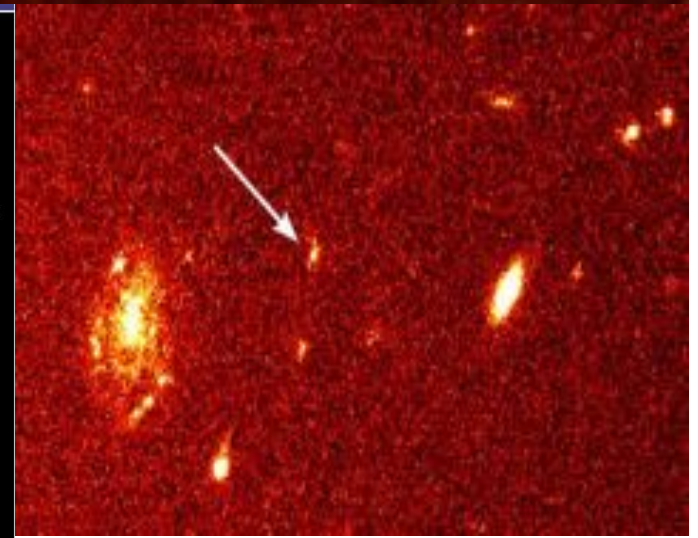
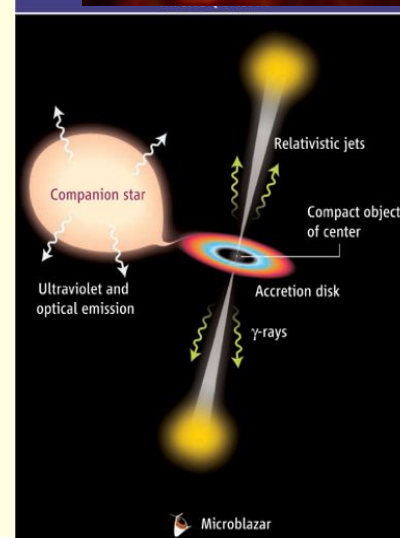
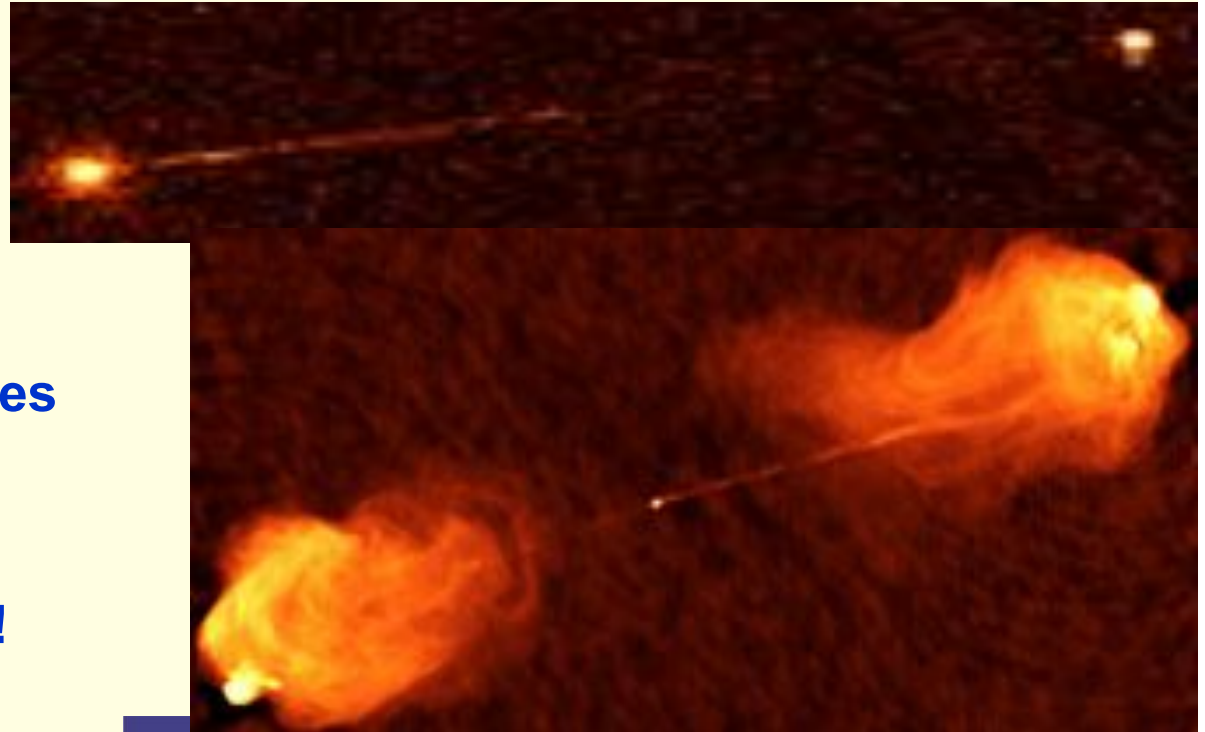
Astrophysics and Indirect Detection

- Resolution of N-body simulations
 - Phase space integrations?
 - Have to separate signal from “noise”
 - Galactic diffuse
 - Extragalactic diffuse
 - Sources
 - Positrons
 - AMS2 when?
 - Pulsar sources
 - e^+ propagation slaved to p waves
 - Increases e^+ fraction
 - More dwarfs, but are they clean?
 - Galactic center full of sources
 - Fermi + CTA can sort out?
 - $\langle\sigma v\rangle < 3 \times 10^{-26} \text{cm}^3 \text{s}^{-1}$
 - $< 1 \text{GeV} - \sim 5 \text{TeV}$
- Fermi Monterey



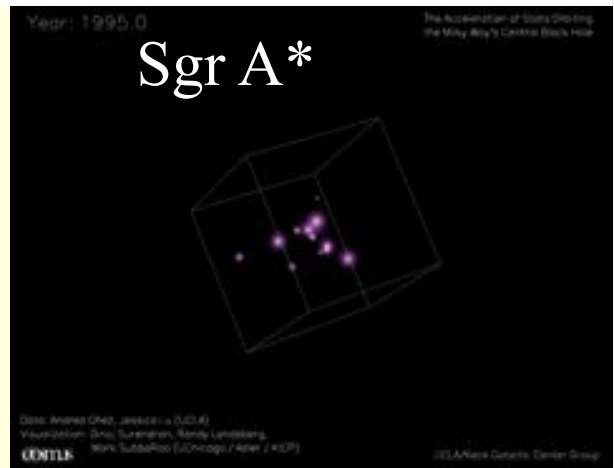
Black Holes

- **Astrophysical detection**
 - Galactic Nuclei
 - X-ray binaries
 - Gamma-ray Bursts
 - Black hole birth cries
- **Disks and Jets**
 - Common and robust
 - Many unstable modes!
- **How are they made?**
 - Accretion rate crucial
 - Magnetic field crucial
 - Spin crucial
- **Ergosphere exploration**





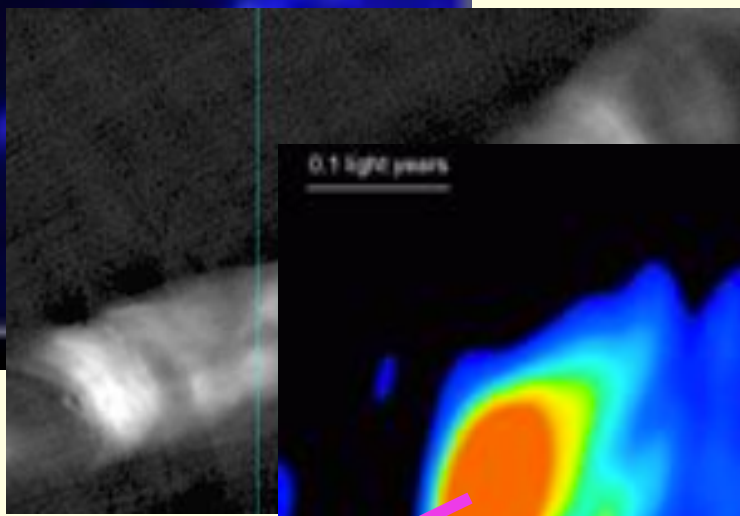
Event Horizon Telescope!



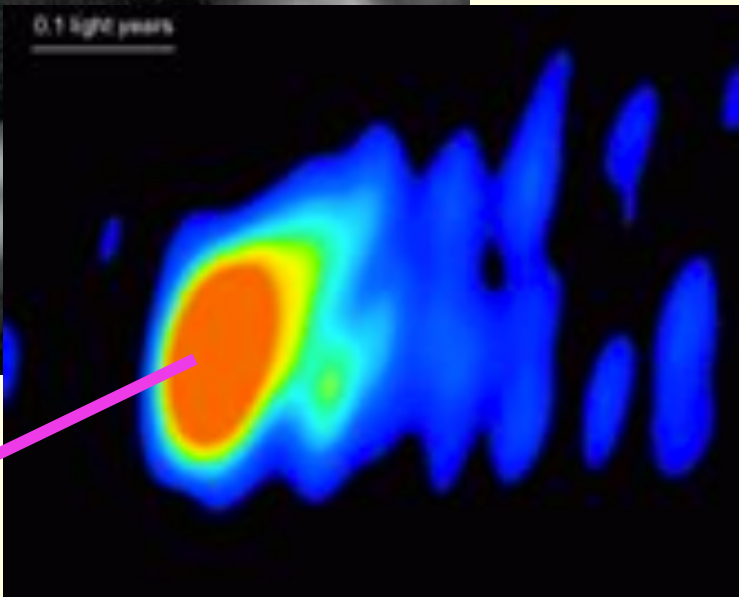
4 million solar mass



6 billion solar mass

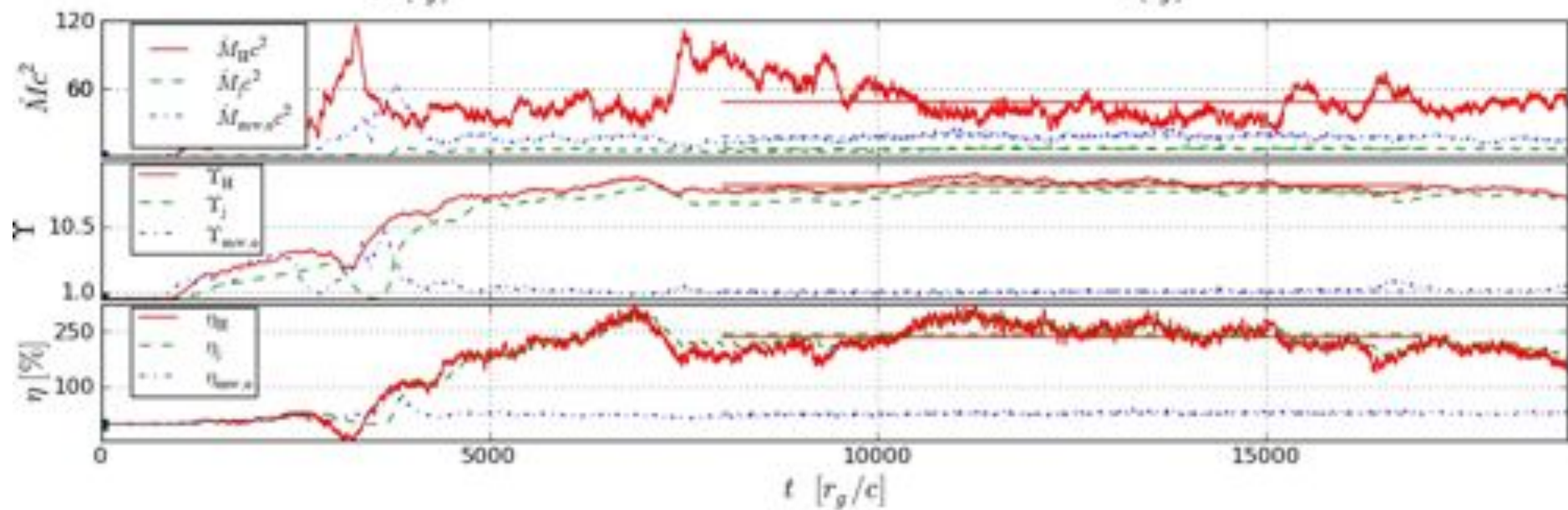
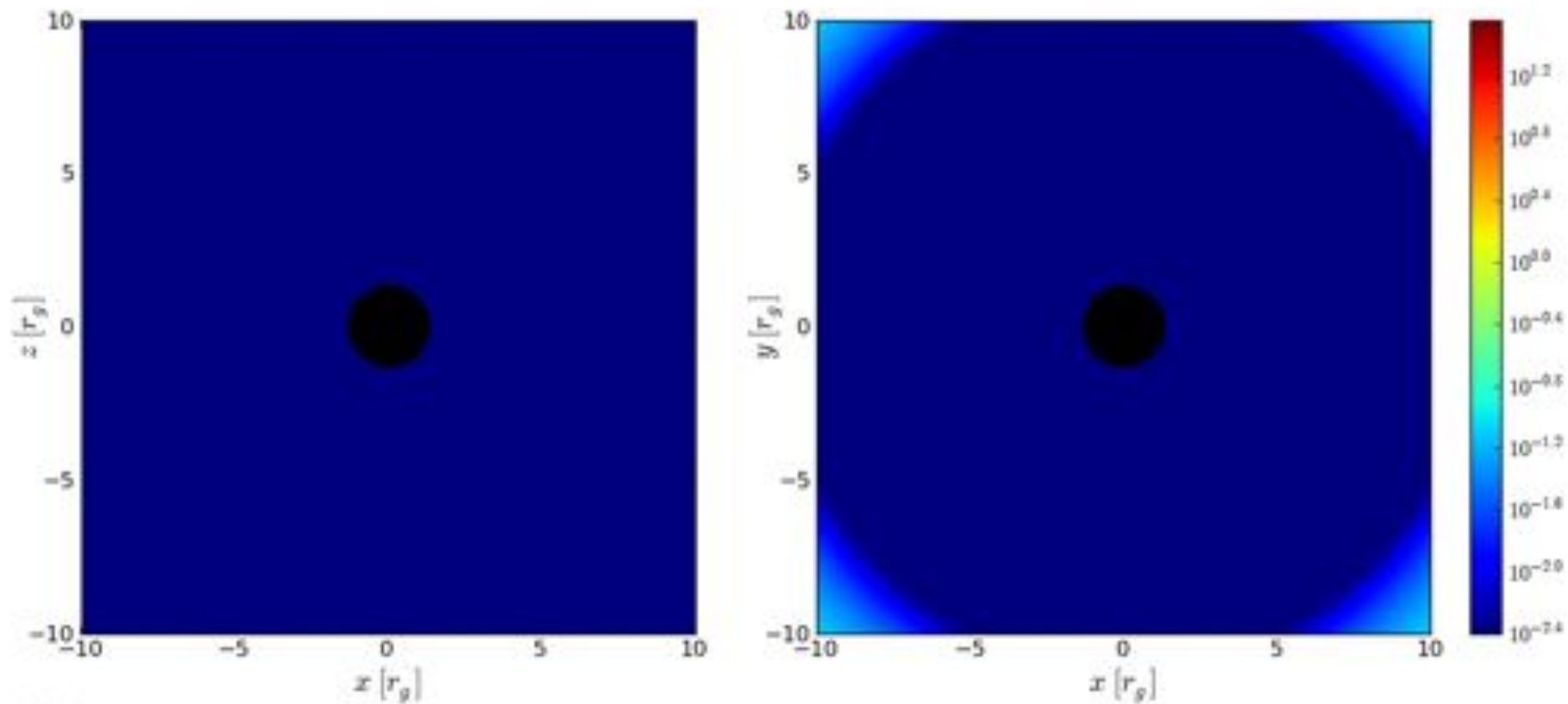


Simulations!



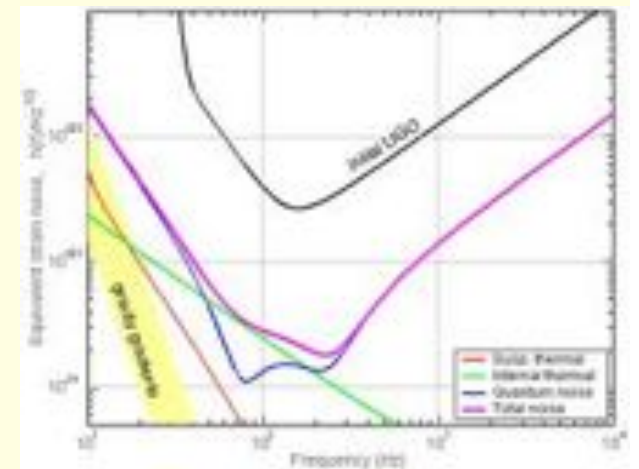
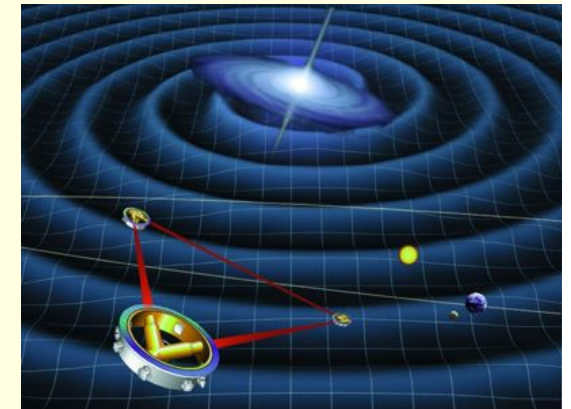
0.01 light yr ~ 10 m
(Doeleman et al.)

Fermi Monterey



Gravitational Radiation

- **Binary NS/WD dipole emission to ~ 0.001**
 - **Indirect**
- **Adv LIGO, VIRGO...Direct detection ~ 2015**
 - **10 x sensitivity; 1000 x volume?**
 - **10 per year?**
- **Multi-messenger sources**
 - **EM, ν triggers, blind sources**
 - Swift/SVOM?,
 - PTF, ROTSE...,
 - LOFAR...,
 - IceCube...
 - **Neutron star coalescence**
 - 10 per year?
 - Short GRB
 - **Magnetars, glitches**



“Direct” detection by pulsar timing

- **Fermi MSPs**

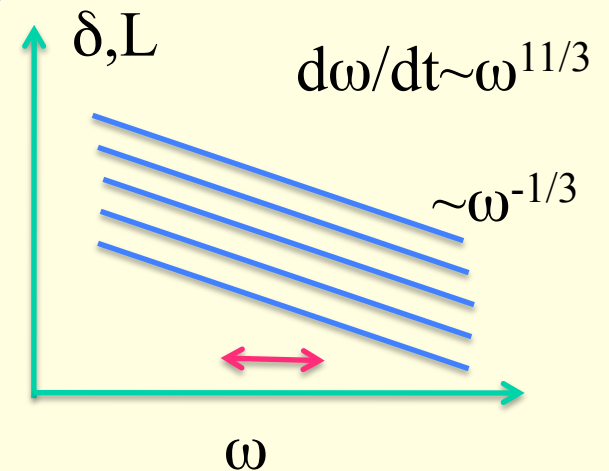
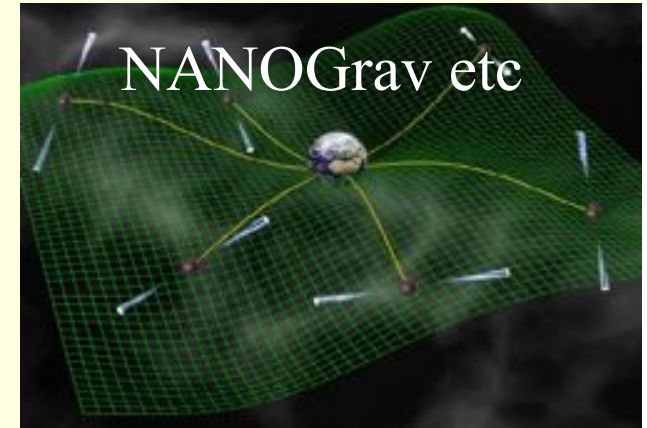
- Great collaboration with radio astronomy
- Quality not quantity
- Better than 40 ns arrival times
- Cross-correlation over many lines of sight

- **Two-body systems**

- Bound and unbound; heavy, distant binaries
- $\lambda \ll d \ll r \sim R$
- $h \sim \mu m / pr < 10^{-15}$
- $t \sim \omega^{-1} \sim p^{3/2} m^{-1/2} \sim 3 \text{yr}$
- $\delta \sim ht \sim L/r \sim 10 \mu_g m_g^{2/3} r_{\text{Gpc}}^{-1} \text{ ns}$
 - Dominated by waves within $t \ll d$
 - Relate incidence to wave torque

- **Background**

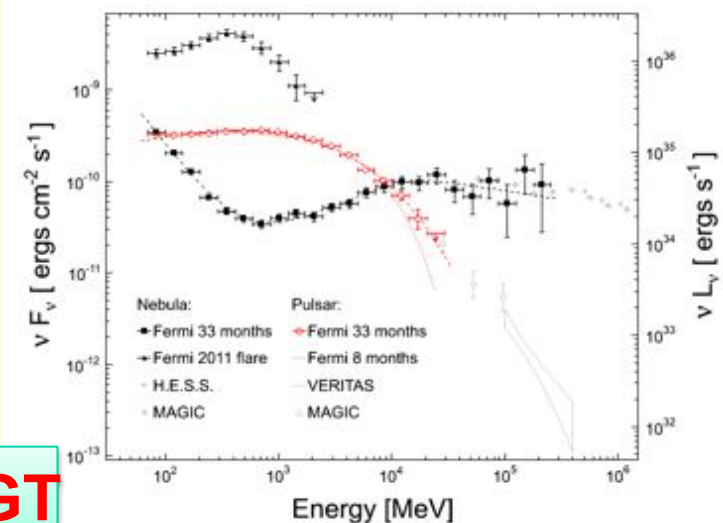
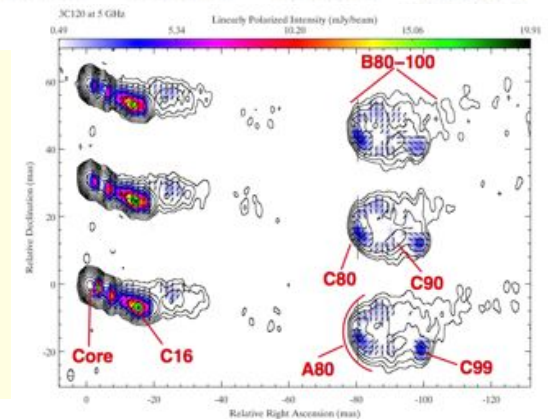
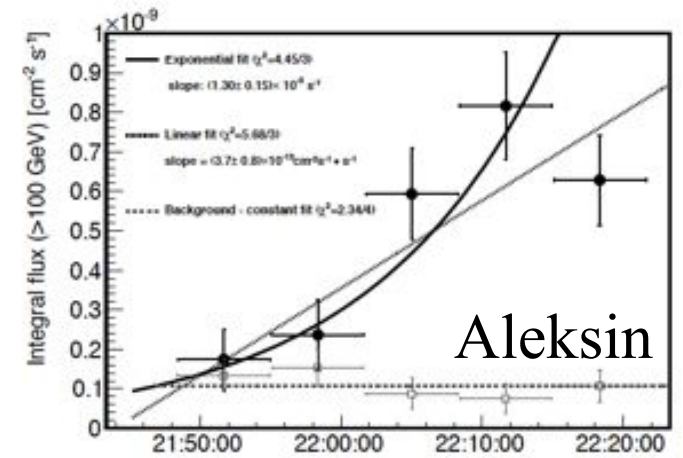
- Lighter, slower systems
- Cosmological?



**Optimize S/N
given constraints
on black hole mass
build up over time**

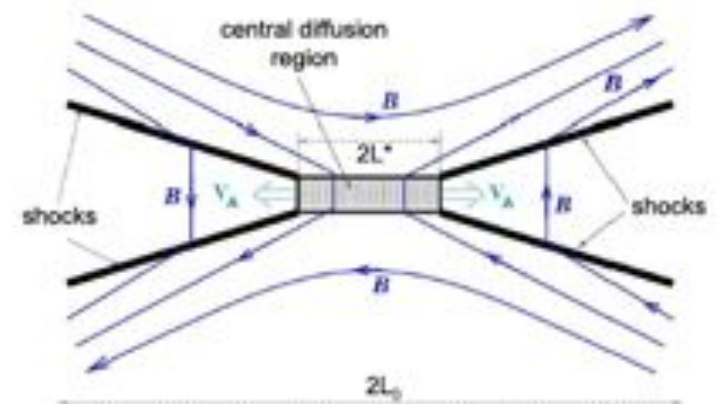
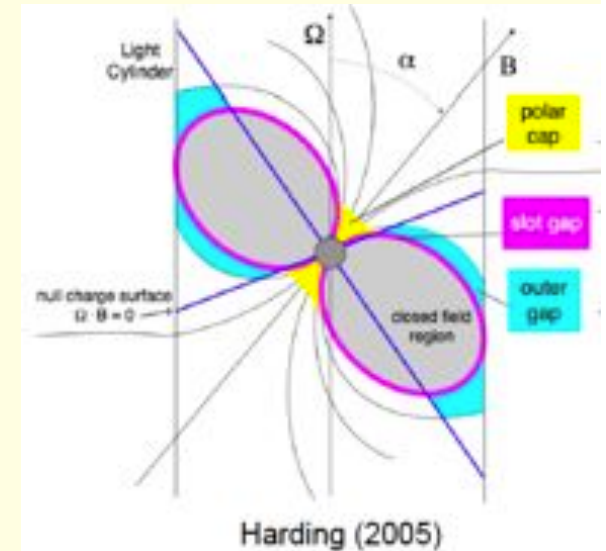
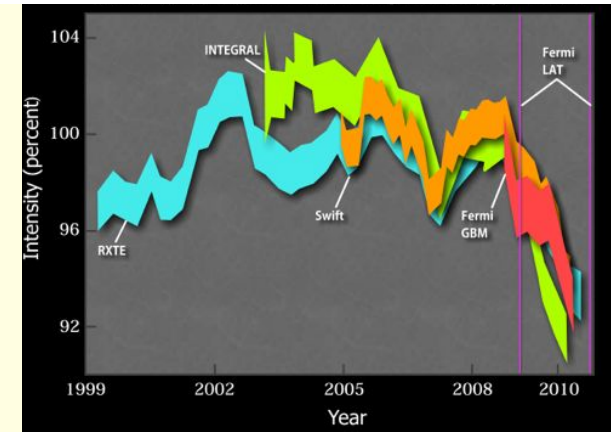
Extreme Electrodynamics

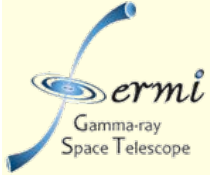
- **TeV variation in AGN jets**
 - PKS 1222+21 --10 min
 - MKN 501-- 5 min
 - PKS 2155-304--2 min?
 - Outside “Gammasphere”
- **Rapid variation from 100pc?**
 - $t_{\text{var}} \ll R/\Gamma c$
- **Rapid acceleration in jets**
 - UHECR
 - >100 TeV X-rays in M87
- **Crab Nebula**
 - $t_{\text{var}} < 10^{-4} R_{\text{neb}}/c$
 - Radiation reaction limit
 $\sim \alpha^{-1} m_e c^2 \sim 60 \text{ MeV}$



Currents

- $L \sim I^2 Z_0 \sim V^2 / Z_0$; $Z_0 \sim 100 \Omega$
 - AGN, $V \sim 300 \text{ EV}$, $I \sim 3 \text{ EA}$; UHECR
 - Crab, $V \sim 30 \text{ PV}$, $I \sim 300 \text{ TA}$; GeV flares
- Currents filament in plasmas
 - Reconnection
 - Shocks
 - Pinches
- Concentrate energy in small volume, impulsively
 - Giant flares
 - $E \sim B$
 - Can be radiation-reaction limited





Unscripted Discovery

- **Seth Digel's Summary**
- **5,6,7'th Fermi Symposium Summaries**