

# DM and baryogenesis as two sides of the same coin

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*Particlegenesis Program,*

*KITP-2014*

# 1.TWO (NAIVELY UNRELATED) PROBLEMS: DM AND BARYOGENESIS (PARTICLEGENESIS).

■ 1.“NAIVE” MORAL: DARK MATTER REQUIRES NEW (UNKNOWN) FIELDS

■ 2. “NAIVE” MORAL: NEW FIELDS MUST BE NONBARYONIC. ARGUMENTS COME FROM STRUCTURE FORMATION REQUIREMENTS, BBN, DECOUPLING DM FROM RADIATION, ETC

■ THIS PROPOSAL: INSTEAD OF “NEW FIELDS”  $\longrightarrow$  “NEW PHASES” (DENSE COLOUR SUPERCONDUCTOR) OF “OLD FIELDS”

■ INSTEAD OF “BARYOGENESIS”  $\longrightarrow$  “SEPARATION OF CHARGES” OF CONVENTIONAL FIELDS (QUARKS AND GLUONS) AT  $\theta \neq 0$

■ SOME ELEMENTS OF THIS IDEA HAVE BEEN TESTED AT RHIC AND THE LHC (THOROUGH THE SO CALLED CHIRAL MAGNETIC EFFECT AND CHARGE SEPARATION EFFECT, *Khazzeev and AZ, 2007*). IT IS, IN FACT, INITIATED A NEW FIELD IN HYDRODYNAMICS WITH NEW CP ODD HYDRO-PARAMETERS RESULTED FROM ANOMALIES. RECENT ACTIVITIES: 4-MONTHS PROGRAM AT SIMONS CENTER, WORKSHOPS AT BNL ON CP ODD EFFECTS IN QCD, ETC.

■ WE PROPOSE THAT ON THE GLOBAL LEVEL THE UNIVERSE IS SYMMETRIC. THE SEPARATION OF BARYON CHARGES IS ORIGINATED AT THE QCD SCALE AS A RESULT OF THE AXION DOMAIN WALL DYNAMICS (THE SO-CALLED N=1 AXION DOMAIN WALL IS CHARACTERIZED BY A SINGLE UNIQUE VACUUM STATE AND THE QCD-SCALE SUBSTRUCTURE INSIDE THE WALL.).

■ SOME CHARGES ARE LOCKED IN FORM OF LARGE DENSE QUARK MATTER NUGGETS (AND ANTI-NUGGETS).

■ THE NUGGETS REMAIN STABLE OVER COSMOLOGICAL TIMESCALES AND SERVE AS DM (SIMILAR TO THE WITTEN'S STRANGELETS BUT WITH EXTRA PRESSURE DUE TO THE N=1 AXION DOMAIN WALLS).

■ WE TAKE THE ADVANTAGE OF STRONG CP VIOLATION RESULTING FROM  $\theta \neq 0$  DURING THE QCD PHASE TRANSITION. IT PRODUCES THE NUGGET-ANTI NUGGET ASYMMETRY. THIS SOURCE OF LARGE CP VIOLATION IS NOT AVAILABLE ANYMORE TODAY.

■ STRONG CP VIOLATION IN QCD: FROM A “FUNDAMENTAL PROBLEM” IT BECOMES A “FUNDAMENTAL KEY ELEMENT” IN RESOLUTION OF “MATTER-ANTIMATTER ASYMMETRY PUZZLE” IN OUR UNIVERSE.

■ INSTEAD OF CONVENTIONAL LOCAL FIELDS (SUCH AS WIMPS) THE DM IN OUR FRAMEWORK IS A MACROSCOPICAL COMPOSITE OBJECT WITH A TYPICAL NUCLEAR DENSITY, SIMILAR TO WITTEN'S STRANGELETS.

■ IF THE NUGGETS ARE SUFFICIENTLY LARGE IN SIZE (THEREFORE THEY ARE VERY MASSIVE) THE OBSERVATIONAL CONSEQUENCES DUE TO THESE OBJECTS WILL BE SUPPRESSED BY SMALL NUMBER DENSITY

$$\text{typical example : } n \sim (\text{fm})^3, \quad B \sim 10^{25}, \quad R \sim 10^{-5} \text{cm}, \quad M \sim 10\text{g},$$

■ A SMALL GEOMETRICAL FACTOR REPLACES A WEAK COUPLING CONSTANT (TYPICAL FOR WIMPS) FOR SUFFICIENTLY LARGE NUGGETS

$$\epsilon \sim S/V \sim B^{-1/3} \ll 1$$

■ A FUNDAMENTAL MEASURE IS THE BARYON TO ENTROPY RATIO IS DETERMINED BY FORMATION TEMPERATURE  $T_{\text{form}}$  AT WHICH THE NUGGETS AND ANTI-NUGGETS HAVE COMPLETED THEIR FORMATION. THIS TEMPERATURE IS BASICALLY HAS THE QCD SCALE  $T_{\text{form}} \simeq 41 \text{ MeV}$  CLOSE TO THE GAP  $\Delta \sim 100 \text{ MeV}$  WHEN COLOUR SUPERCONDUCTOR PHASE SETS IN INSIDE THE NUGGETS

$$T_{\text{form}} \simeq 41 \text{ MeV} \quad \eta \equiv \frac{n_B - n_{\bar{B}}}{n_\gamma} \simeq \frac{n_B}{n_\gamma} \sim 10^{-10}$$

- MECHANISMS OF FORMATION AND PROPERTIES OF QUARK NUGGETS (IN COLOUR SUPERCONDUCTING PHASE) AND WITTEN'S STRANGELETS ARE VERY DIFFERENT (E.G. NO NEED FOR THE FIRST ORDER PHASE TRANSITION IN OUR CASE).
- AXION DOMAIN WALL NETWORK DYNAMICS REPLACES THE BUBBLE'S COLLISIONS IN THE WITTEN'S MECHANISM WHICH REQUIRES 1-ORDER PHASE TRANSITION.
- EXCESS OF ANTIMATTER IS LOCKED AWAY IN ANTIMATTER NUGGETS REQUIRING NO FUNDAMENTAL BARYON ASYMMETRY TO EXPLAIN THE OBSERVED MATTER/ANTIMATTER ASYMMETRY.
- THE NUGGETS HAVE A LARGE BINDING ENERGY ( $\sim 100$  MEV) SUCH THAT LARGE BARYON CHARGE IN THE NUGGETS IS NOT AVAILABLE TO PARTICIPATE IN BBN AT  $T \sim \text{MEV}$ .
- TECHNICAL PROBLEM WITH QUANTITATIVE COMPUTATIONS OF THE NUGGET'S FORMATION: EVEN THE QCD PHASE DIAGRAM IS STILL UNKNOWN AT  $\theta \neq 0$ . LATTICE NUMERICAL COMPUTATIONS DO NOT HELP MUCH TO STUDY A NON-EQUILIBRIUM DYNAMICS FOR  $\theta \neq 0$ .

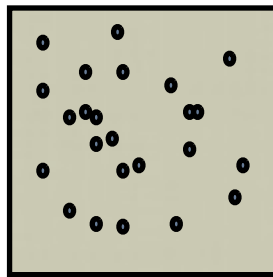
# MATTER IN THE UNIVERSE

A model which explains both the matter-antimatter asymmetry and the observed ratio of visible matter to DM

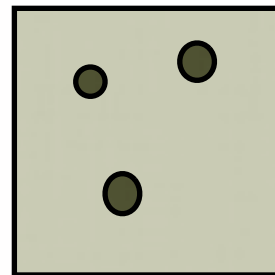
$$B_{tot} = 0 = B_{nugget} + B_{visible} - \bar{B}_{antinugget}$$

$$B_{DM} = B_{nugget} + \bar{B}_{antinugget} \simeq 5 B_{visible}$$

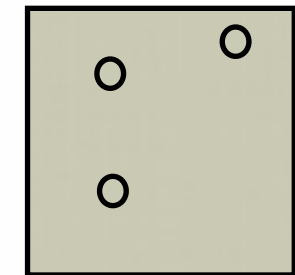
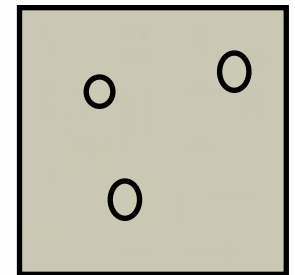
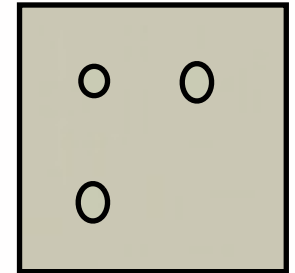
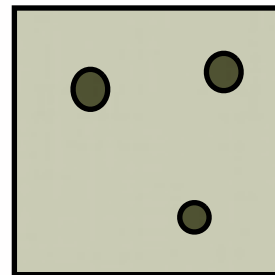
The ratio  $B_{nugget}/\bar{B}_{antinugget} \simeq 2/3$  at the end of formation is determined by the sign of the CP violating parameter  $\theta \sim 1$



One part:  
visible matter



Two parts:  
matter nuggets



Three parts:  
anti-matter nuggets

## 2. OBSERVATIONAL COSMOLOGICAL PUZZLES

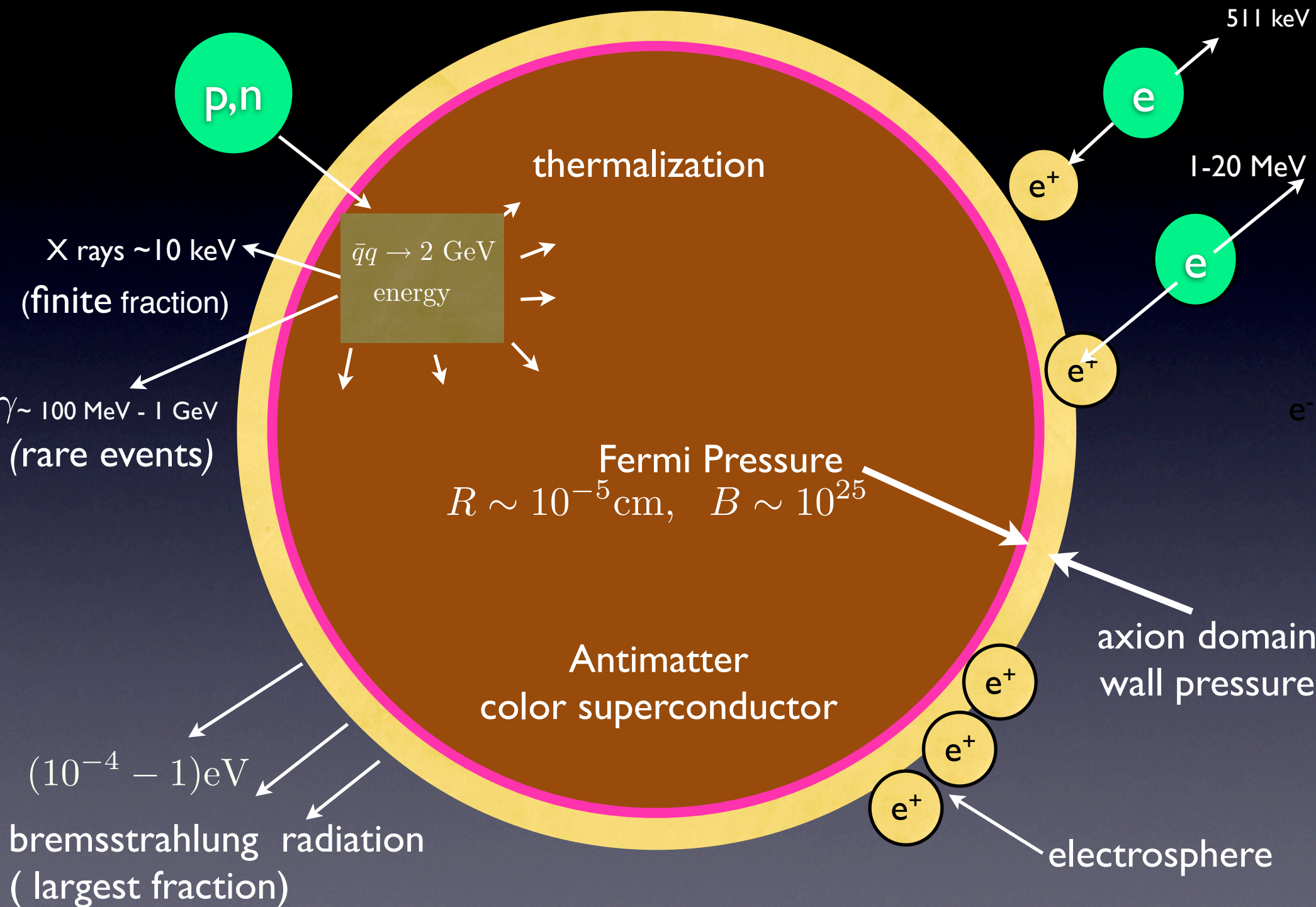
(NAIVELY UNRELATED STORY)

- SEVERAL INDEPENDENT OBSERVATIONS OF THE GALACTIC CORE SUGGEST UNEXPLAINED SOURCES OF ENERGY:
- THE MOST KNOWN CASE IS THE 511 KEV LINE (INTEGRAL) WHICH HAS PROVEN VERY DIFFICULT TO EXPLAIN WITH CONVENTIONAL ASTROPHYSICAL POSITRON SOURCES.
- A SIMILAR, BUT LESS KNOWN MYSTERY IS THE EXCESS OF GAMMA-RAY PHOTONS DETECTED BY COMPTEL ACROSS A BROAD ENERGY RANGE 1-20 MEV. SUCH PHOTONS HAVE BEEN FOUND TO BE VERY DIFFICULT TO PRODUCE VIA KNOWN ASTROPHYSICAL SOURCES

- DETECTION BY THE CHANDRA SATELLITE OF DIFFUSE X-RAY EMISSION FROM ACROSS THE GALACTIC BULGE PROVIDES A PUZZLING PICTURE: AFTER SUBTRACTING KNOWN X-RAY SOURCES ONE FINDS A RESIDUAL DIFFUSE THERMAL X-RAY EMISSION CONSISTENT WITH VERY HOT PLASMA ( $T = 10$  KEV). SOURCE OF ENERGY FUELLING THIS PLASMA IS A MYSTERY.
- THE WMAP EXPERIMENT HAS REVEALED AN EXCESS OF MICROWAVE EMISSION,  $23 < \nu < 61$  GHz FROM THE CENTER OF OUR GALAXY. THIS EXCESS, WHICH IS UNCORRELATED TO THE KNOWN FOREGROUNDS, IS KNOWN AS THE ``WMAP HAZE''.
- RECENT MEASUREMENTS BY THE ARCADE2 EXPERIMENT UNAMBIGUOUSLY SHOW AN EXCESS IN THE ISOTROPIC RADIO BACKGROUND AT FREQUENCIES AROUND THE GHz SCALE.
- ORIGIN OF THESE EXCESSES REMAINS A MYSTERY AS ALL CONVENTIONAL SOURCES FOR THESE DIFFUSE EMISSIONS ARE NOT CAPABLE TO DESCRIBE THE OBSERVATIONS.



# Antiquark nugget structure. Source of emission



### **3. EXCESS OF DIFFUSE GAMMA-RAYS IN 1-20 MEV BAND. OBSERVATIONS.**

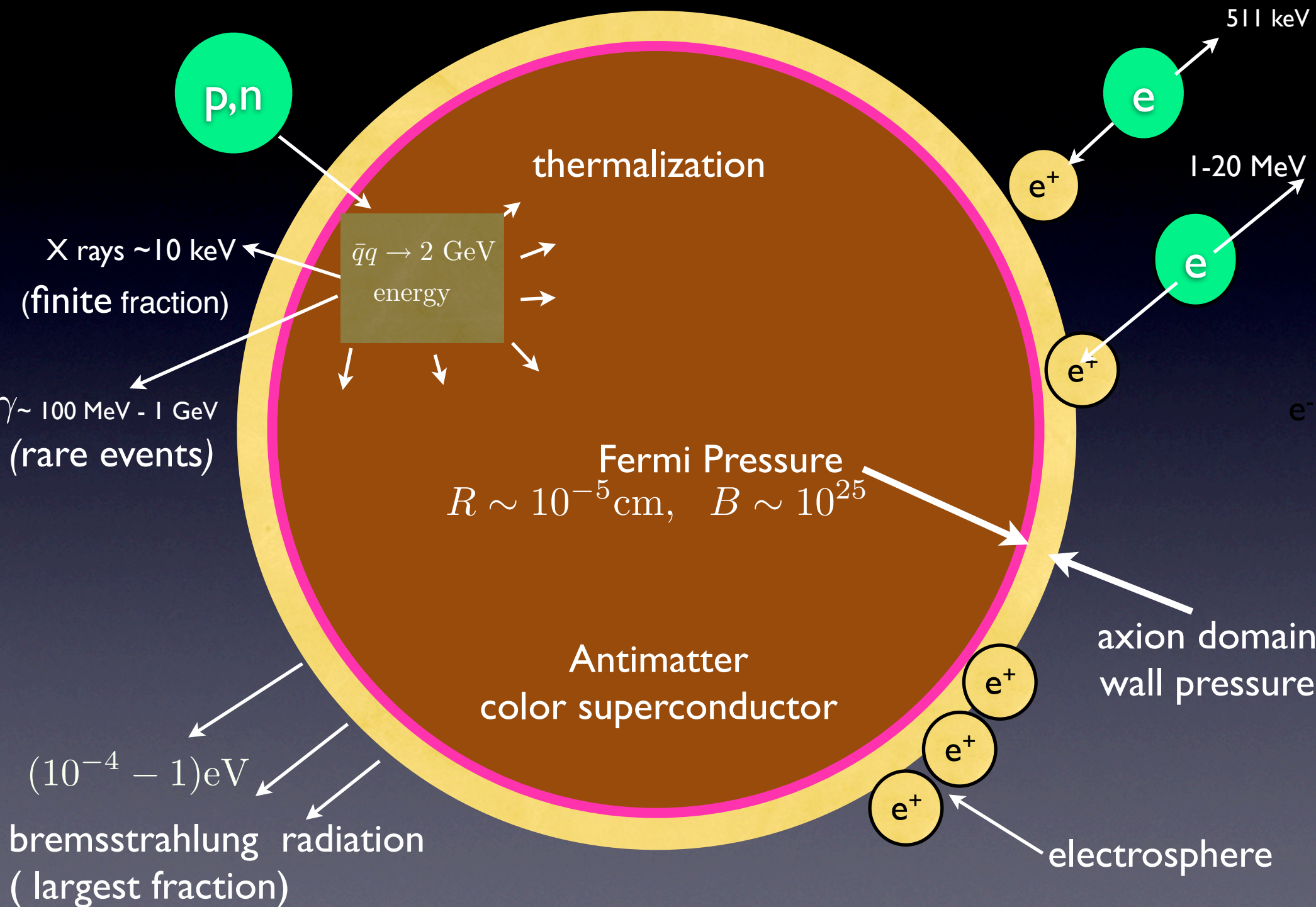
- **THE FLUX OF GAMMA RAYS IN THE 1-20~ MEV RANGE MEASURED BY COMPTEL REPRESENTS A MYSTERY.**
- **THE MODELS (OF COSMIC RAYS) FOR DIFFUSE GALACTIC GAMMA RAYS FIT THE OBSERVED SPECTRUM WELL FOR A VERY BROAD RANGE OF ENERGIES, 20 MEV- 100 GEV. THE MODELS TYPICALLY ALSO GIVE A GOOD REPRESENTATION OF THE LATITUDE AND THE LONGITUDINAL DISTRIBUTIONS. HOWEVER, THE MODELS FAIL TO EXPLAIN THE EXCESS IN THE 1-20 MEV RANGE OBSERVED BY COMPTEL.**
- **SOME ADDITIONAL GAMMA RAY SOURCES ARE REQUIRED TO EXPLAIN THIS EXCESS IN THE 1-20 MEV RANGE (STRONG ET AL, 2004). THESE DATA SUGGEST THE EXISTENCE OF AN ENERGY SOURCE BEYOND CURRENTLY ESTABLISHED ASTROPHYSICAL PHENOMENON.**
- **THE OBSERVED SPECTRUM IS EXTREMELY DIFFICULT TO EXPLAIN BY KNOWN ASTROPHYSICAL MECHANISMS.**

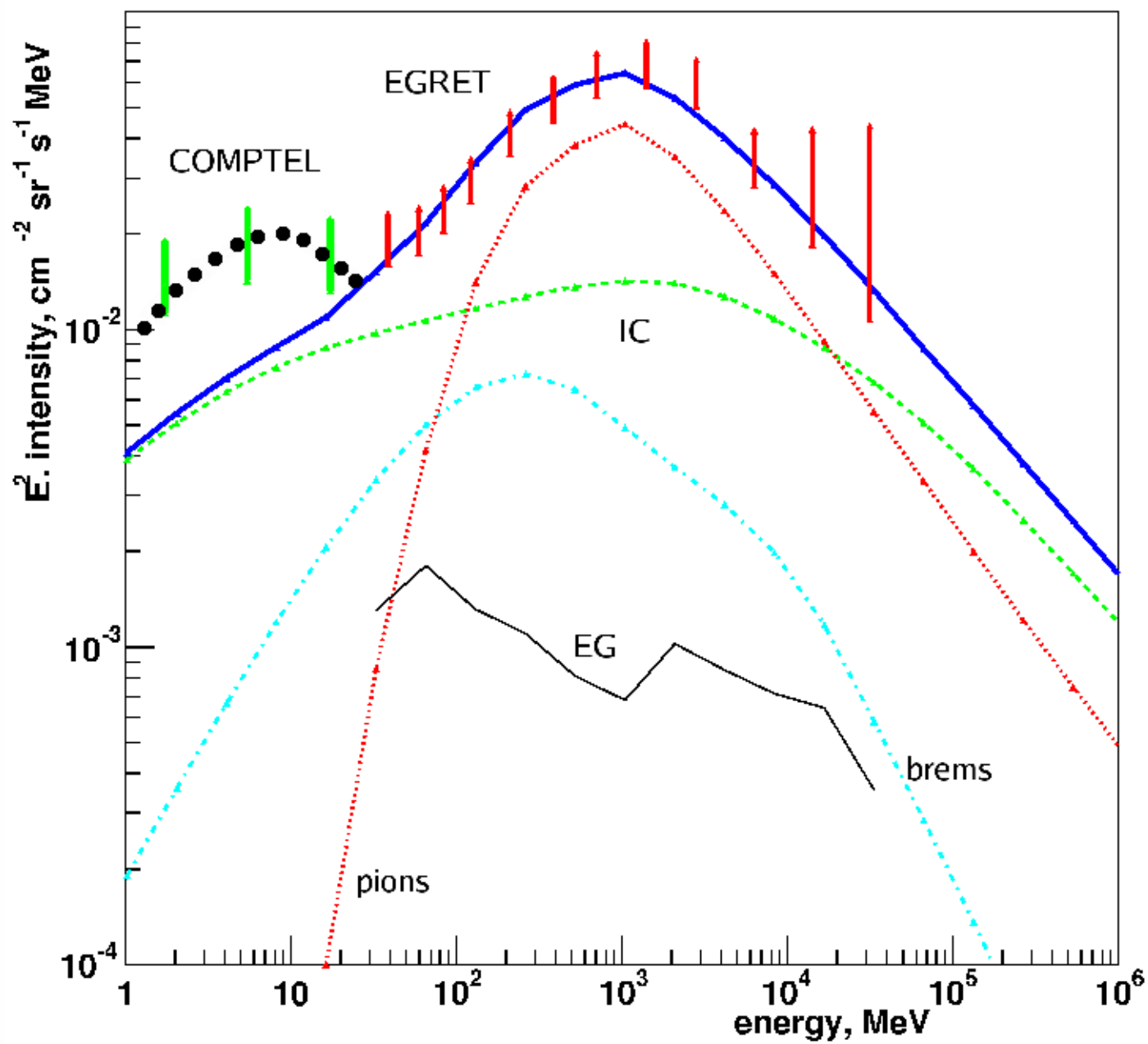
## 4. EXCESS OF DIFFUSE GAMMA-RAYS IN 1-20 MEV BAND.

(EXAMPLE OF A TYPICAL COMPUTATION IN THIS MODEL)

- NON-RESONANCE DIRECT ANNIHILATION WOULD PRODUCE A BROAD SPECTRUM AT 1~20 MEV WHICH WE IDENTIFY WITH THE EXCESS OBSERVED BY COMPTEL. THIS CONTINUUM EMISSION MUST ALWAYS ACCOMPANY THE 511 KEV LINE AND THE TWO MUST BE SPATIALLY CORRELATED (PREDICTION).
- THE RELATIVE RATIO OF 1-20~ MEV PHOTONS AND 511 KEV LINE IS VERY SENSITIVE TO THE PROFILE FUNCTION OF ELECTRO-SPHERE. IT WAS COMPUTED USING THE THOMAS-FERMI APPROXIMATION. THERE ARE NO FREE PARAMETERS IN COMPUTATIONS.
- NO NEW PARAMETERS ARE REQUIRED TO EXPLAIN THE EXCESS IN THE 1-20~ MEV RANGE -- THE NORMALIZATION AND SPECTRUM ARE FIXED BY 511 KEV FLUX AND KNOWN QED AND QCD PHYSICS.

# Antiquark nugget structure. Source of emission





## 5. IMMEDIATE (GENERIC) CONSEQUENCES:

- IF DM IS ORIGINATED FROM THE QCD SCALE THE RELATION  $\Omega_{DM} \sim \Omega_B$  MAY COME NATURALLY AS BOTH CONTRIBUTIONS ARE ORIGINATED FROM THE SAME QCD PHYSICS.

- THE DM NUGGETS MADE OF QUARKS/ANTIQUARKS DO INTERACT WITH VISIBLE MATTER. HOWEVER, THE INTERACTION IS STRONGLY SUPPRESSED: A SMALL GEOMETRICAL FACTOR  $\sigma/M \simeq 10^{-10} \text{cm}^2/\text{g}$  REPLACES THE STANDARD REQUIREMENT FOR THE COUPLING CONSTANT (TYPICAL FOR WIMPS) TO BE WEAK. IT IS WELL BELOW ANY COSMOLOGICAL LIMITS

$$\sigma/M \leq 1 \text{cm}^2/\text{g}$$

- ALL EFFECTS ARE PROPORTIONAL TO A SINGLE UNKNOWN PARAMETER COMPUTED ALONG THE LINE OF SIGHT

$$B^{-1/3} \int dr \rho_{visible}(r) \cdot \rho_{DM}(r)$$

- STANDARD TIGHT CONSTRAINT ON ANTIMATTER PRESENCE IN OUR UNIVERSE DOES NOT APPLY HERE AS IT DOES NOT RADIATE/ ANNIHILATE AS CONVENTIONAL HADRONIC MATTER.
- RARE EVENTS OF ANNIHILATION OF THE VISIBLE MATTER WITH ANTIMATTER NUGGETS PROVIDE AN EXCESS OF RADIATION WHICH APPARENTLY HAVE BEEN OBSERVED IN DIFFERENT FREQUENCY BANDS: 511 KEV, 1-20 MEV, X -RAYS, MICROWAVES (WMAP HAZE),.....
- ON LARGE SCALES, THE NUGGETS BEHAVE AS STANDARD COLLISIONLESS COLD DARK MATTER. HOWEVER: SOME MODIFICATIONS ARE EXPECTED IN DENSE REGIONS (GALAXIES), WHERE DM DOES INTERACT STRONGLY WITH VISIBLE MATTER.
- THE IDEA OF THE CHARGE SEPARATION DURING THE QCD PHASE TRANSITION AT  $\theta \neq 0$  (THE KEY ELEMENT OF THE PROPOSAL) CAN BE TESTED AT RHIC AND LHC. RECENT EXPERIMENTAL RESULTS ( STAR, ALICE COLLABORATIONS) SUPPORT CHARGE SEPARATION EFFECT (LOCAL P, CP VIOLATION IN HEAVY ION COLLISIONS HAS BEEN OBSERVED).

# RELEVANT LITERATURE

(EXCESSES OF RADIATION AT DIFFERENT FREQUENCY BANDS AS A RESULT OF ANNIHILATION OF THE DM NUGGETS WITH VISIBLE MATTER)

- DM-BARYOGENESIS JCAP 2003; PRD. 2005
- 511 KEV LINE (INTEGRAL) PRL. 2005
- 1-20 MEV EXCESS (COMPTEL) JCAP 2008; PRD. 2010
- X-RAY EMISSION (CHANDRA) JCAP 2008
- $23 < \nu < 61$  GHz (WMAP HAZE) PRD. 2008
- $\nu \sim 1$  GHz (ARCADE 2) PHYS. LETT. B 2013
- MINI-REVIEW PREPARED FOR  
SNOWMASS E-PROCEEDINGS arxiv:1305.6318



## 6. CONCLUSION: GALACTIC EXCESS EMISSIONS

- “NON- BARYONIC DARK MATTER” COULD BE ORDINARY BARYONIC MATTER WHICH IS NOT IN THE “NORMAL HADRONIC PHASE”, BUT RATHER, IN THE “EXOTIC” COLOUR SUPERCONDUCTING PHASE.
- IN THIS PHASE THE BARYON CHARGE IS NOT AVAILABLE FOR BB NUCLEOSYNTHESIS
- A SMALL GEOMETRICAL FACTOR  $\epsilon \sim S/V \sim B^{-1/3} \ll 1$  REPLACES A WEAK COUPLING CONST.
- CONVENTIONAL KILLING PROBLEM (FOR OTHER MODELS) OF INSUFFICIENT CP VIOLATION IS AUTOMATICALLY RESOLVED HERE: CP VIOLATION IS VERY LARGE AT THE QCD PHASE TRANSITION; IT IS DIMINISHED BY NOW AS A RESULT OF THE AXION DYNAMICS.

- ALL EFFECTS ARE PROPORTIONAL TO ONE AND THE SAME MORPHOLOGICALLY ASYMMETRIC NORMALIZATION FACTOR (WHICH IS A SINGLE UNKNOWN PARAMETER IN THE ENTIRE FRAMEWORK).

$$B^{-1/3} \int dr \rho_{visible}(r) \cdot \rho_{DM}(r)$$

- THIS IS VERY DIFFERENT (E.G. MORPHOLOGICALLY) FROM CONVENTIONAL DM MODELS WHERE EFFECT IS PROPORTIONAL TO

$$\int dr \rho_{DM}^2(r) \text{ (annihilating DM)} \quad \text{or} \quad \int dr \rho_{DM}(r) \text{ (decaying DM)}$$

- ALL RELATIVE INTENSITIES ARE FIXED BY CONVENTIONAL PHYSICS. IT COVERS 11 ORDERS OF MAGNITUDE WHERE SOME EXCESS OF THE RADIATION HAS BEEN OBSERVED:

$\omega \sim 10^{-4}$  eV for WMAP haze to  $\omega \sim 10$  MeV for COMPTTEL

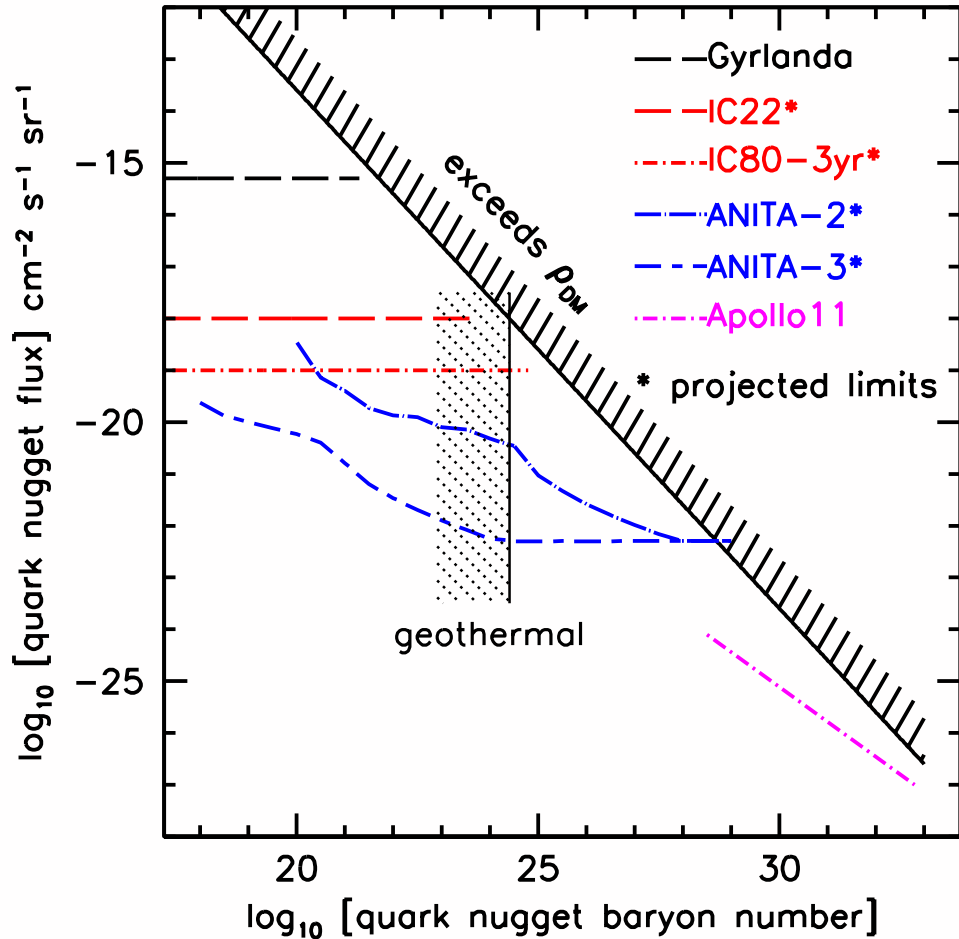
## 7. RECENT DEVELOPMENT. PROSPECTS FOR GROUND BASED (SUBORBITAL) DETECTION.

- K.LAWSON, PRD 83 (2011), 103520
- P. GORHAM, PRD 86 (2012), 123005
- K.LAWSON, PRD 88 (2013), 043519
- EXPECTED FLUX AT THE EARTH'S SURFACE

$$\frac{dN}{dA dt} = nv \approx \left( \frac{10^{25}}{B} \right) km^{-2} yr^{-1}$$

- THIS FLUX IS WELL BELOW THE SENSITIVITY OF ANY CONVENTIONAL WIMP DM SEARCHES. THE FLUX OF NUGGETS IS SIMILAR TO THAT OF COSMIC RAYS NEAR GZK LIMIT.

- AN EXTENSIVE AIR SHOWER WILL BE DEVELOPED AROUND THE PRIMARY PARTICLE.
- THE SHOWER IS DRIVEN NOT BY KINETIC ENERGY OF THE PRIMARY, BUT BY ENERGY RELEASED IN MATTER-ANTIMATTER ANNIHILATION.
- THERE ARE MANY SIMILARITIES (IN TERMS OF SPECTRUM) WITH CONVENTIONAL AIR SHOWER PRODUCED BY A SINGLE ULTRAHIGH ENERGY PRIMARY.
- HOWEVER, THERE ARE SOME IMPORTANT DIFFERENCES
- GENERALLY, THE NUGGETS CARRY SUFFICIENT MOMENTUM TO TRAVEL THROUGH THE EARTH AND EMERGE FROM OPPOSITE SIDE.



Plot from P. Gorham,  
PRD 86 (2012) 123005

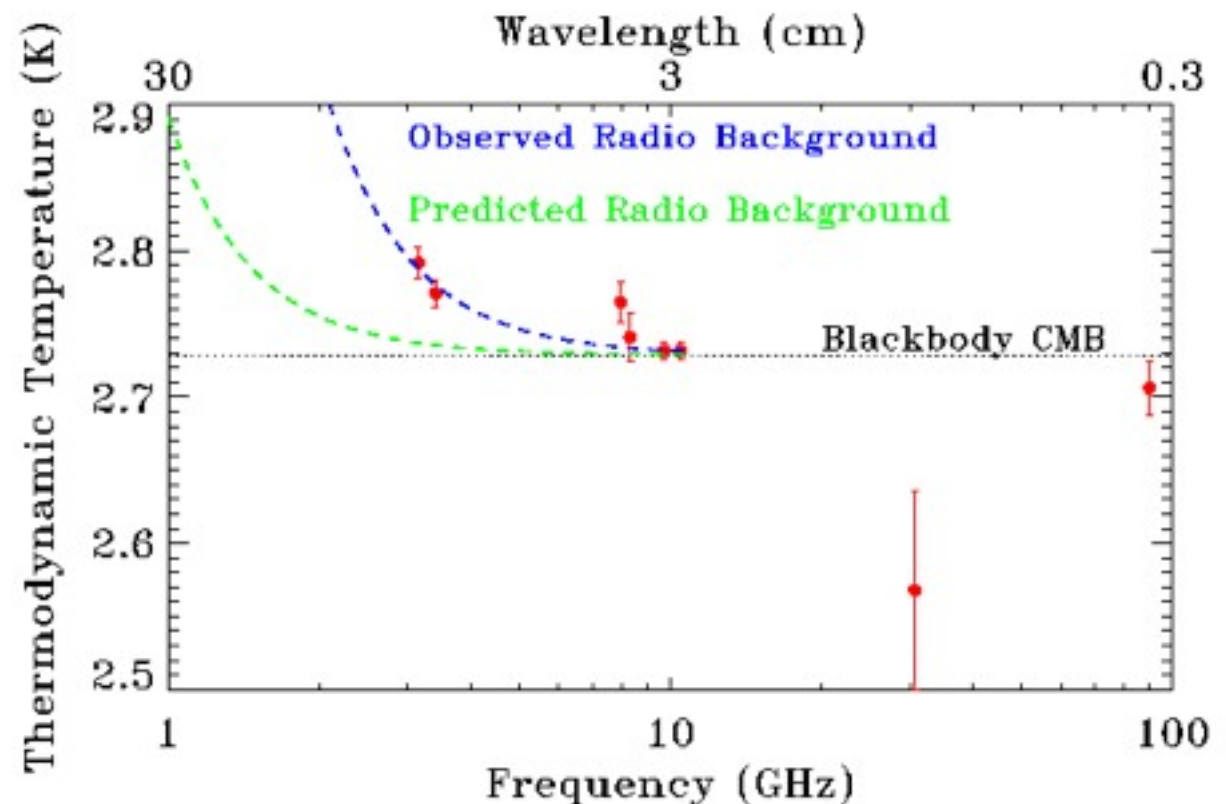
Existing and projected limits  
on anti-quark nugget fluxes

**CONCLUSION:** ground based detection prospects:

1. *Radio emission of anti-quark nuggets with  $B = 10^{24} - 10^{28}$  can be studied by balloon-borne instruments such as ANITA.*
2. *Analysis of existing ANITA-2 data for these event signatures has begun, and results may be expected within the next few years.*

## 8. ISOTROPIC RADIO BACKGROUND FROM ARCADE 2

- Measurements by the ARCADE 2 experiment unambiguously show an excess in the isotropic radio background at frequencies below GHz scale. This radio excess seems impossible to fit through reasonable modifications to the spectra of known background radio sources



- THE BASIC PROPOSAL TO EXPLAIN THE EXCESS: THE ANNIHILATION HAS BEEN HAPPENING BETWEEN ANTI-NUGGETS AND MATTER EVEN IN EARLY UNIVERSE AT  $z \sim 1000$  (SIMILAR TO THE PRESENT ANNIHILATIONS AT THE GALACTIC CENTER)
- THE NUGGETS NORMALLY MAKE SMALL CONTRIBUTION TO THE ISOTROPIC CMB BACKGROUND. HOWEVER, THE THERMAL SPECTRUM OF THE CMB FALLS AS  $\omega^3$  BELOW PEAK WHILE THE NUGGET CONTRIBUTION REMAINS ESSENTIALLY CONSTANT

$$\frac{dQ}{d\omega dt} \sim \frac{T^3 \alpha^{5/2}}{\pi} \sqrt[4]{\frac{T}{m}} \left(1 + \frac{\omega}{T}\right) \exp\left(-\frac{\omega}{T}\right) \ln \frac{T}{\omega}, \quad T \simeq 1\text{eV}$$

- THERMAL EMISSION SPECTRUM OF A NUGGET IS ALMOST FLAT AT ENERGIES BELOW THE NUGGET TEMPERATURE  $\omega \ll T$
- THIS FEATURE OF “FLATNESS” OF THE SPECTRUM RESULTS IN AN OBSERVED ISOTROPIC BACKGROUND “ANTENNA TEMPERATURE” THAT SEEMS TO GROW WITH THE THIRD POWER OF FREQUENCY (IN COMPARISON WITH CMB WHICH SHOULD STAY CONSTANT).

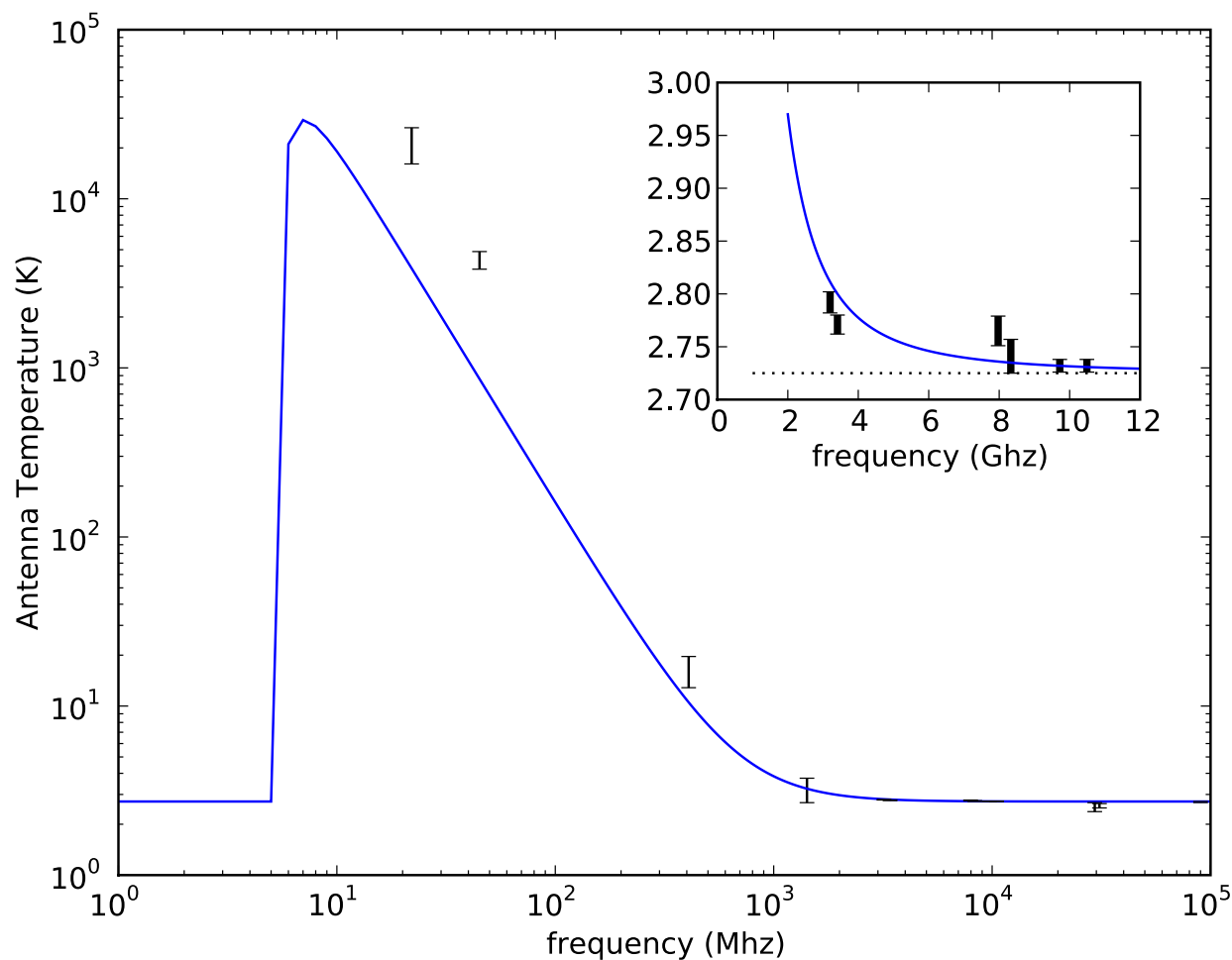
- WITH COMPUTED SPECTRUM WE CAN NOW DETERMINE THE PRESENT DAY RADIO BACKGROUND DUE TO THE PRESENCE OF QUARK MATTER (ANTI) NUGGETS. THIS IS ACCOMPLISHED BY INTEGRATING THE SOURCE DENSITY OVER ALL REDSHIFTS “Z” CORRECTING FOR THE REDSHIFTING OF PHOTON FREQUENCY AFTER EMISSION.

$$I(\nu) = \frac{c}{H_0} \int \frac{dz}{(1+z)h(z)} \frac{\rho_{DM}}{M_N} \frac{dE'}{d\nu dt} [\nu(1+z), T(z)]$$

- THE INTEGRAL IS SATURATED BY  $z \sim 1000$  AND IS NOT SENSITIVE TO LATE TIME COMPLICATIONS (SUCH AS REHEATING, STRUCTURE FORMATION, ETC)
- UNCERTAINTY IS PARAMETRIZED BY THE INITIAL TEMPERATURE OF THE NUGGETS  $T_{LS}$  AT THE TIME OF LAST SCATTERING (DURING CMB FORMATION). THIS PARAMETER IS CALCULABLE IN PRINCIPLE AS IT IS DETERMINED BY CONVENTIONAL PHYSICS. OUR ESTIMATES ARE CONSISTENT WITH  $T_{LS} \sim 0.25 \text{ eV}$  SHOWN ON THE PLOT BELOW.



Solid line is the contribution due to the annihilations of anti nuggets with normal matter at early times ( $z \sim 1000$ ). Conventional radio background apparently can not explain the observations, similar to the previous plot representing  $\sim$ GHz bands.



# CONCLUSION. PROSPECTS FOR DETECTION

■ CONCLUSION-1. EXCESSES OF RADIATION FROM THE CENTER OF GALAXY. NORMALIZATION (DETERMINED BY THE NUGGET'S MASS  $B \sim 10^{25}$ ) IS FIXED BY 511 KEV LINE. OTHER OBSERVED EXCESSES IN DIFFERENT FREQUENCY BANDS (COVERING 11 ORDERS OF MAGNITUDE) ARE FIXED BY CONVENTIONAL WELL ESTABLISHED PHYSICS.

■ CONCLUSION-2. PROSPECTS TO DETECT THE NUGGETS HITTING EARTH (SHOULD BE CONTRASTED WITH STUDIES FROM GALAXY RADIATION). ANITA-2 OR SIMILAR INSTRUMENTS.

■ CONCLUSION-3. PROSPECTS TO DETECT THE ISOTROPIC EXCESS IN RADIO FREQUENCY BANDS (APPARENTLY OBSERVED). THE RADIATION IS ORIGINATED AT VERY DIFFERENT TIME SCALE  $Z \sim 1000$  (SHOULD BE CONTRASTED FROM RADIATIONS ORIGINATED FROM THE GALACTIC CENTER AND FROM EARTH'S ATMOSPHERE).