Chapter 22

Solving the Mystery of the Origin of Anomalous Excess Positrons

22.1 Brief History of Predictions, Experiments, Discrepancy, and Explanations

The production of the positron in collisions of cosmic-ray protons with protons of the interstellar medium has been discussed in detail in numerous studies (e.g., Stecker 1970; Orth & Buffington 1976; Protheroe 1982; Dermer 1986a, 1986b; Murphy, Dermer, & Ramaty 1987), and the muons created through decays of secondary pions and kaons are fully polarized, which results in electron/positron decay asymmetry, which in turn causes a difference in their production spectra (Moskalenko & Strong 1997).

In 1981, R.J. Protheroe made a new calculation of the flux of secondary positrons above 100 MeV ~ 1 TeV expected for various propagation models. The models investigated were the leaky box model, the disk-halo diffusion model, the dynamical halo model, and the closed galaxy model.

In 1997, I.V. Moskalenko and A.W Strong made a new calculation of the cosmic-ray secondary spectrum, using a diffusive halo model for galactic cosmic-ray propagation. (See the Appendices on pp. 704–706 in Moskalenko and Strong (1998), "Production and propagation of cosmic-ray positrons and electrons," *Astrophysics Journal* **493:** 694–707). The result of their calculation and prediction is the solid line in Figure 22-1-1 below.

To obtain such results, these authors used all the arsenals that modern physics could give to them, especially the standard model, as evident from their paper.

Here, in their calculation, one cannot find any mistake and defect according to the standard model.

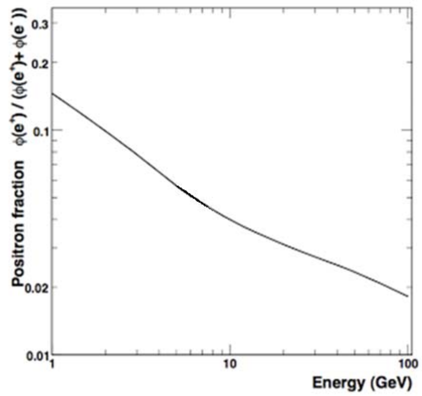


Figure 22-1-1

However, despite a history of conflicting results, positron excess in the galactic cosmic-ray positron between 1 and 100 GeV appears to have been confirmed by PAMELA (Adriani *et al*. 2009), thereby known sometimes as the PAMELA anomaly.

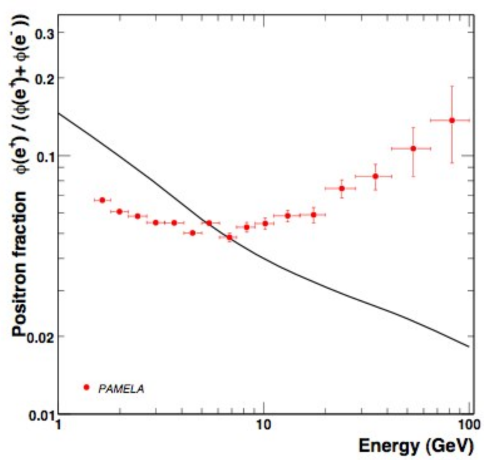


Figure 22-1-2 **(Source: Adriana *et al*. 2008. "Observation of an anomalous positron abundance in the cosmic radiation." Available at http://arxiv.org/pdf/0810.4995.pdf.)**

The PAMELA anomaly reveals an apparent excess of high energy from 10 to 100 GeV positrons in cosmic rays, which is not accompanied by a corresponding excess in anti-protons. This excess had been found previously by ATIC and PPB-BEST, and was confirmed recently by the FERMI collaboration (in accordance with previous indications from HEAT and the Alpha Magnetic Spectrometer (AMS-01))

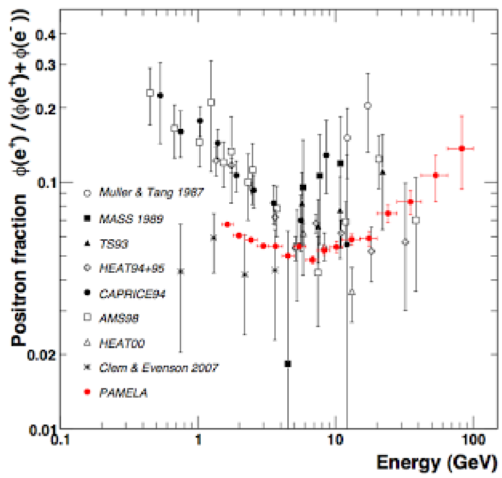


Figure 22-1-3 **(Source: Adriana *et al*. 2008. "Observation of an anomalous positron abundance in the cosmic radiation." Available at http://arxiv.org/pdf/0810.4995.pdf.)**

In Figure 22-1-3 we can see at a glance almost all the extensive history of experiments on the positron fraction from 1987 to 2009.

The AMS-02, a particle physics experiments module mounted on the International Space Station (ISS), was launched by the Space Shuttle Endeavour flight STS-134 on 16 May 2011 and installed on 19 May 2011.

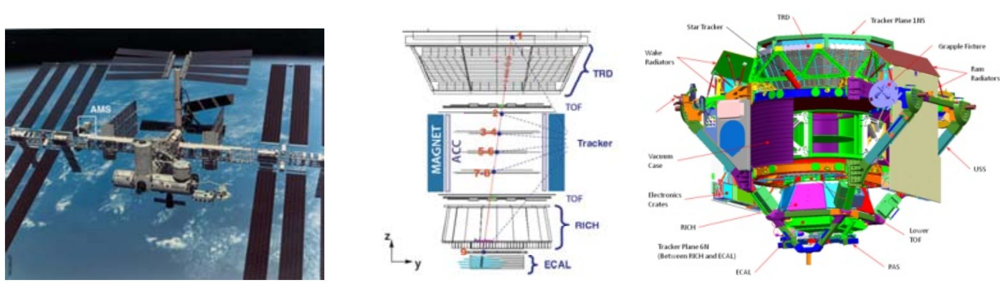


Figure 22-1-4. A schematic of the AMS on board the International Space Station. (Source: http:// http://www.ams02.org/.)

Figure 22-1-4 shows a schematic of the AMS detector. Tracker planes 1 through 9 measure the particle charge and momentum. The transition radiation detector (TRD) identifies the particle as an electron. The time of flight counters (TOF) measures the charge and ensures that the particle is downward-traveling. The ring imaging Cerenkov detector (RICH) independently measures the charge and velocity. The electromagnetic calorimeter (ECAL) measures the 3D shower profile, independently identifies the particle as an electron, and measures its energy. An electron is identified by (i) an electron signal in the TRD, and (ii) an electron signal in the ECAL; the matching of the ECAL shower energy and the momentum is measured with the tracker and magnet. A 1.03 TeV electron event was measured by AMS-02 in the bending (y-z) plane.

By July 2012, AMS-02 had recorded over 18 billion cosmic-ray events since its space installation. In March 2013, at a seminar at CERN, Professor Samuel Chao Chung Ting, the principal investigator of AMS-02, gave a report about the first 6.8×10^6 primary positron and electron events collected. Some highlights of his report are the following:

(i) At energies <10 GeV, the positron fraction within positron-to-electron ratios decreases with increasing energy.

(ii) A steady increase in the positron fraction occurs from 10~250 GeV.

(iii) The determination of the behavior of the positron fraction from 250 to 350 GeV and beyond requires more statistics.

(iv) The slope of the positron fraction versus energy decreases by an order of magnitude from 20 to 250 GeV, and no fine structure is observed. The agreement between the data and the model shows that the positron fraction spectrum is consistent with $e^{\pm}$ fluxes, each of which is the sum of its diffuse spectrum and a single power law source.

(v) The positron-to-electron ratio is consistent with isotropy; $\delta \leq 0.036$ at the 95% confidence level.

These observations show the existence of new physical phenomena, whether from a particle physics or an astrophysical origin. Despite the enormous cost of AMS-02, it is still cheaper than the cost of accelerators that scientist wanted to have. Its ultimate value is summed up in the valuable results it provides, demonstrated in Figure 22-1-5.

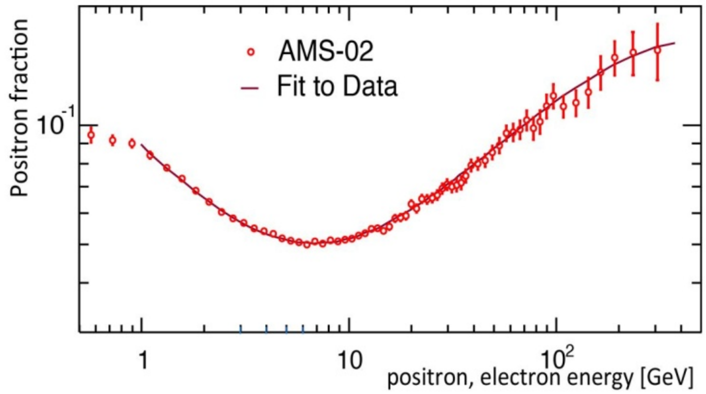


Figure 22-1-5 (Source: http://www.ams02.org/)

Figure 22-1-6 shows the relative accuracy and sensitivity of the AMS-02 results.

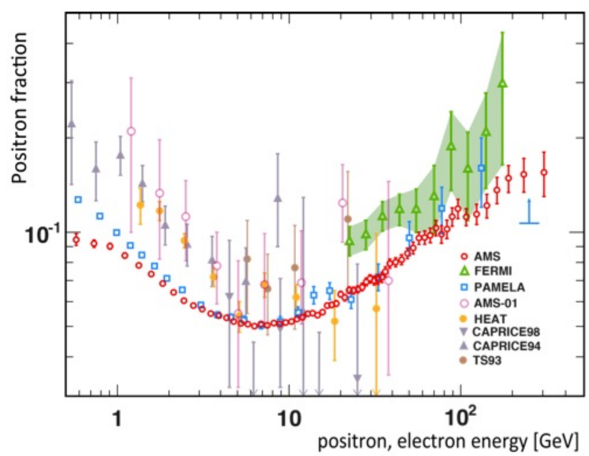


Figure 22-1-6 (Source: http://stephenwebb.info/tag/fermi/)

There is clearly an increase in the positron abundance from the 100 to 350 GeV high energy that cannot be understood by standard models describing the secondary production of cosmic-ray, like the one Moskalenko and Strong had calculated and predicted.

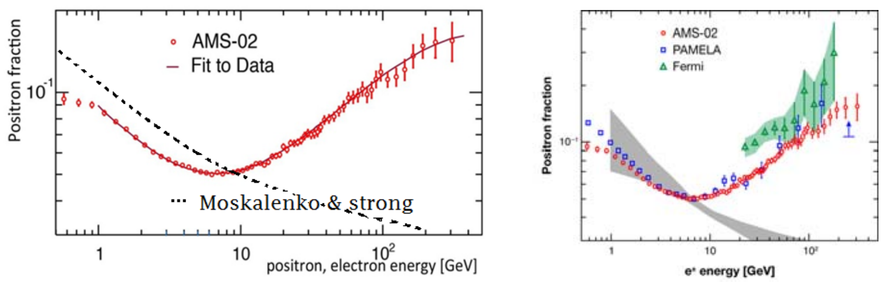


Figure 22-1-7

In Figure 22-1-7, we can find discrepancy between the expensive result of AMS-02 and the correct prediction from Moskalenko and Strong. There are, of course, several possible astrophysical and particle physical explanations. Nearby sources of positrons (e.g., supernovas or pulsars), which suffer fewer losses than typical galactic positrons because they are younger (e.g., Eichler & Maor 2005; profumo 2008), contribute harder spectra. Nevertheless, dark-matter annihilation (e.g., Zeldovich *et al*. 1980; Tylka& Eichler 1987; Tylka 1989; Hooper *et al*. 2009) or decay (Eichler 1989; Arvanitaki et al. 2009) has long been suggested as a possible source. Sufficed to say, the astronomical origin may be of a pulsar, SNRs, secondary cosmic-ray, cosmic-ray propagation, or particle physical origin, or may be annihilating dark matter and decaying dark matter. But none of these suggestions can explain why, from 8 GeV, the positron fraction is increased with increasing energy, despite the total number of electrons and positrons created is decreased.

Therefore, the origin of these excess positrons has become a mystery of modern particle physics and astrophysics.

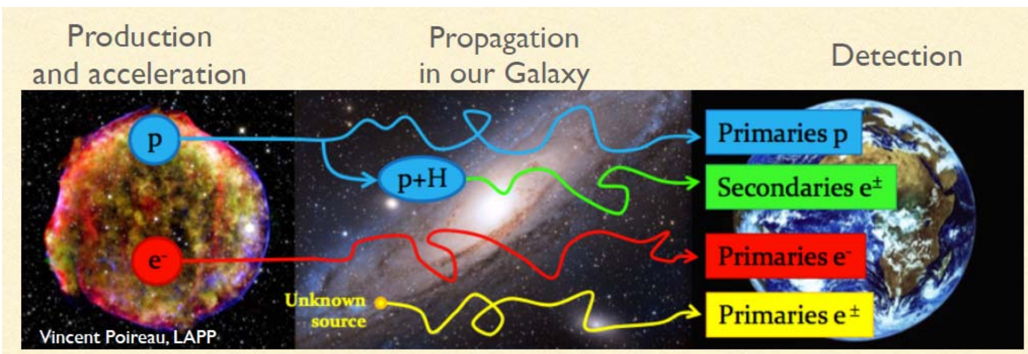
22.2. Solving the Origin of Excess Positrons and Meaning of Positron Excess by CFLE Theory

New results from the Alpha Magnetic Spectrometer experiment disagree with current models that describe the origin and movement of the high-energy particles called cosmic rays.

Therefore, according to cosmic ray researchers they think as “it’s a real head scratcher; we cannot say we are seeing dark matter, but we are seeing results that cannot be explained by the conventional wisdom about where cosmic rays come from and how they get here. All we can say right now is that our results are consistently confusing.”

However, at present, the new cosmic ray data of AMS-02 indicate signal from new physics. This result is not confusing.

According to CFLE theory astrophysical origin of excess positron is AGNs and neutronic seed nova or quark nova that is astrophysical source of gamma ray busts too (cf.§7.6.3).



Here unknown source means quark nova or neutronic seed nova

Figure 22-2-1

By this physical base can be explained essence of positron excess as below.

In particle physics, CP violation is a violation of the postulated CP-symmetry (or Charge conjugation Parity symmetry): the combination of C-symmetry (charge conjugation symmetry) and P-symmetry (parity symmetry). CP-symmetry states that the laws of physics should be the same if a particle is interchanged with its antiparticle (C symmetry), and then its spatial coordinates are inverted ("mirror" or P symmetry).

However, scientists believed that there is no experimentally known violation of the CP-symmetry in quantum chromo dynamics. As there is no known reason for it to be conserved in QCD specifically, this is a "fine tuning" problem known as the strong CP problem.

Experiments do not indicate any CP violation in the QCD sector. For example, a generic CP violation in the strongly interacting sector would create the electric dipole moment of the neutron which would be comparable to 10^{-18} e·m while the experimental upper bound is roughly one trillionth that size. However, theoretically at the end, there are natural terms in the QCD Lagrangian that are able to break the CP-symmetry.

$$\mathcal{L} = -\frac{1}{4}F_{\mu\nu}F^{\mu\nu} - \frac{n_f g^2\theta}{32\pi^2}F_{\mu\nu}\tilde{F}^{\mu\nu} + \bar{\psi}(i\gamma^\mu D_\mu - me^{i\theta'\gamma_5})\psi \qquad \text{22-2-1}$$

The particular value of the θ angle that must be very close to zero (in this case) is an example of a fine-tuning problem in physics, and is typically solved by physics beyond the Standard Model.

Such theoretical end say us why is the strong nuclear interaction force CP-invariant and automatically connectedly say us why the universe does have so much more matter than antimatter?

Simply speaking, answer according to CFLE theory is that strong CP violation and gravitational CP violation are exist, because strong force and related strong charge are origin of gravitational force($\pm$Newtonian gravity) and related gravitational charge($\pm$ Newtonian mass). Therefore, anti gravitational force ($-F_g$) and related anti gravitational charge ($-$Newtonian mass) exist by gravitational CP violation.

Good example is usual hydrogen atomH_1 in this universe. In the usual hydrogen atom H_1 we can find gravitational CP violation, because finally same electrical charge between electron and proton exist mass difference.

$$d_m = \frac{1}{1836} \qquad \text{22-2-2}$$

This violated gravitational CP (dominated matter) in the universe is conserved by anti-verse (dominated anti-mater cf.§13.).

With this simple physical base we can solve every difficult problem of CP violation and positron excess.

Therefore, problem of positron excess is changed problem of excess of positive mass from proton and neutron in this universe.

Now, we can calculate and predict from where is started excess of positive mass of proton by excess positron?

Because rest mass change of proton is maximized by force line curve change from $g = 1$ to $g = 8$ according to CFLE theory, positron excess should be started from the mass of

$$m_{start} = 0.938 \text{ GeV} \times 8$$

$$= 7.504 \text{ GeV} \qquad 22\text{-}2\text{-}3$$

Observed value by AMS-2 is

$$m_{start} = 7.16 \sim 7.80 \text{ GeV} \qquad 22\text{-}2\text{-}4$$

Figure 22-2-1 from AMS-2 show dramatically this point that excess start.

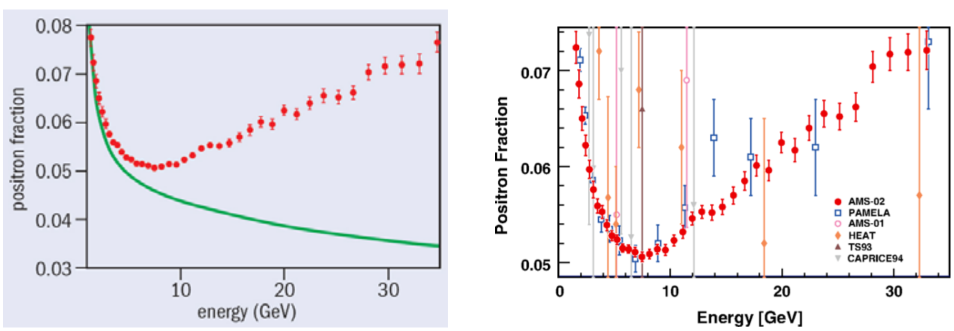


Figure 22-2-2

Related lowest positron fraction at this point is

$$A_{start} \equiv \frac{\Phi_+}{\Phi_- + \Phi_+} = 0.0506 \qquad 22\text{-}2\text{-}5$$

Table 22-2-1from AMS-2 show observed positron fraction as a function of energy

Table 22-2-1. Representative bins of the positron fraction as a function of energy.

Energy (GeV)	N_{e^+}	Fraction	Energy (GeV)	N_{e^+}	Fraction
1.00–1.21	14757	0.0820	74.30–80.00	450	0.0963
1.97–2.28	39475	0.0650	86.00–92.50	398	0.1207
3.30–3.70	31762	0.0559	100.0–115.1	524	0.1205
6.56–7.16	20863	0.0511	115.1–132.1	365	0.1110
7.16-7.80	18033	0.0506	132.1–151.5	271	0.1327
19.37–20.54	3777	0.0625	151.5–173.5	288	0.1374
30.45–32.10	1706	0.0719	173.5–206.0	255	0.1521
40.00–43.39	1616	0.0806	206.6–260.0	178	0.1550
50.87–54.98	1041	0.0887	260.0–350.0	135	0.1590
64.03–69.00	644	0.0974	350.0-500.0	72	0.1471

The positron fraction above 7.5 GeV, where it begins to increase.

Why increase of positron fraction is peaked 260.0~350.0GeV?

Because most inner particle of proton is kaonK^+ (u$\bar{s}$) and kaon(m_{K^+}= 493.667±0.013 MeV) with $g = 5.793595$ is decayed fundamental particles as electron and positron ($e\bar{e}$) by galactic force of neutronic seed(galactron or galacton) in quark novae at this energy.

(u$\bar{s}$) → Bose-Einstein condensate by galactic force → ($e\bar{e}$) 22-2-6

Therefore, maximum force line curve change of strong force from $g = 1$ to $g = 8$ for single quark decay of Kaon is

$$d_g = \frac{8_g}{1_g} = 8 \qquad 22\text{-}2\text{-}7$$

However, As discussed in §.7, quarks can have a fractional static electric charge of $e = \pm\frac{1}{3}$ in CFLE theory, because of the electric force line element curve, as summarized in Figure 22-2-3.

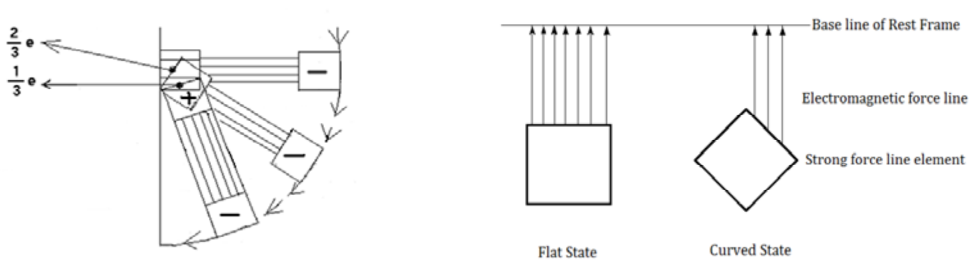


Figure 22-2-3

Therefore, maximum static charge change of strong force from $\frac{1}{3}e_{strong}$ to 1 e_{strong} is

$$d_{charge} = \frac{1e}{1e/3} = 3 \qquad 22\text{-}2\text{-}8$$

Total needed change for kaon K^+decay from (u$\bar{s}$) to ($e\ \bar{e}$) is

$$d_{total} = 8 \times 3 = 24 \qquad 22\text{-}2\text{-}9$$

Therefore, possible positron mass of final fundamental single particle from (u$\bar{s}$) quarks by strong force line and gravitational force line in the air of Earth surface is

$$m_{max} = (0.494\ GeV)(24)^2$$

$$=284.5 \text{ GeV} \qquad 22\text{-}2\text{-}10$$

Because difference between AMS-2 at ISS in space of vacuum and this fundamental particle at Earth surface in the air by gravitational permittivity at $g = 2$ is

$$x_{air} = 1.033548 \qquad 22\text{-}2\text{-}11$$

Final value in vacuum become

$$m_{max} = \frac{284.5}{1.033548}$$

$$= 275.3 \text{ GeV} \qquad 22\text{-}2\text{-}12$$

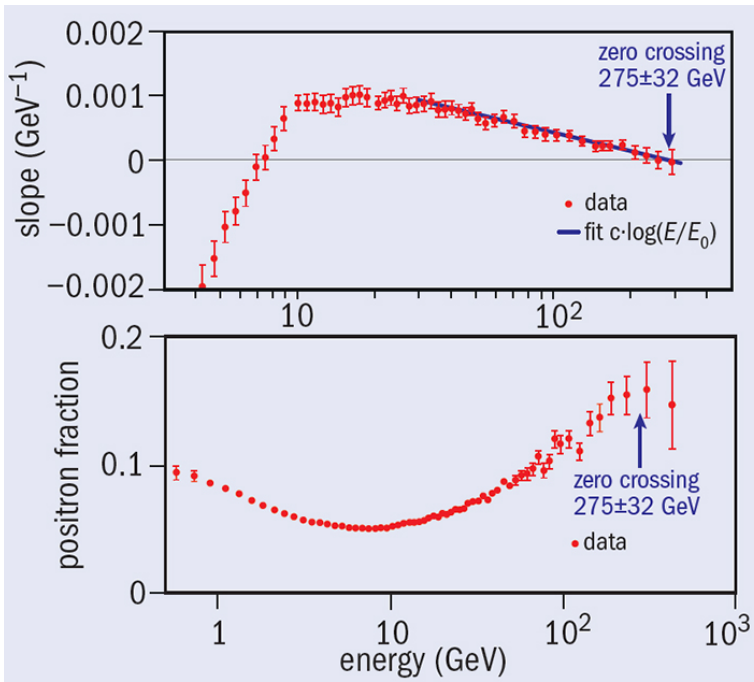


Figure 22-2-4

Observed value by AMS-2 is

m_{max} =275$\pm$32 GeV 22-2-13

The present measurements extend the energy range to 500 Gev and demonstrate that at 275$\pm$32 GeV, the positron fraction is no longer increasing as figure 22-2-4

This agreement means that result of strong CP violation appear positron excess.

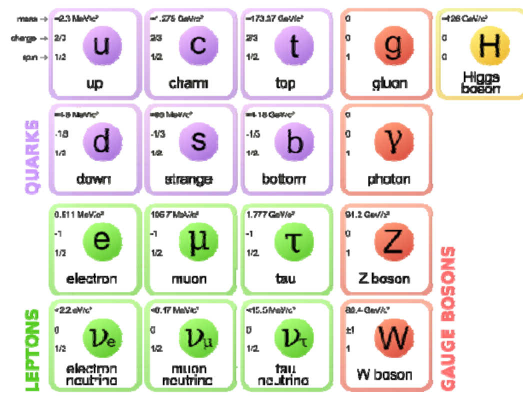


Figure 22-2-5

The top quark that has an electric charge of $+\frac{2}{3}e$, is massive as

$$m_{top} = 173.34 \text{ GeV} \quad 22\text{-}2\text{-}14$$

All of such phenomena occur by curve of force lines as figure 22-2-3

Therefore, now, we can calculate and predict physical base of CP violation as below.

Related positron fraction at 275 ± 32 GeV is

$$A_{peak} \equiv \frac{\Phi_+}{\Phi_- + \Phi_+} = 0.1590 \quad 22\text{-}2\text{-}15$$

Ratio of electron and positron at this energy point is

$$R_{peak} \equiv \frac{\Phi_-}{\Phi_+} = 5.2910 \quad 22\text{-}2\text{-}16$$

This value is force line curve difference between Kaon K^+ and usual electron in Vacuum.

$$g_{R_{peak}} = 5.2910 \quad 22\text{-}2\text{-}17$$

Gravitational permittivity of air at $g = 5.2910$ is

$$Q_g = (0.016774)(5.2910) = 0.088751$$

$$x_{air} = 1.088751$$

Therefore, force line curve of Kaon K^+ is

$g_{air} = (g_{R_{peak}})(x_{air})$

$= (5.2910)(1.088751)$

$= 5.7606$

Related electrical permittivity difference is

$Q_e = (0.000589)(5.2910) = 0.003122$

$x_e = 1.003122$

Final value of force line curve of Kaon $K^+$is

$g_{air} = (5.7606)(1.003122)$

$=5.7786 \approx 5.8$ 22-2-18

Real value (cf.§7.   ) is

g_{air} =5.793595≈ 5.8 22-2-19

This good agreement means that CP violation mechanism of physical base is curve of force lines. That is

$R_{peak} \equiv \frac{\Phi_-}{\Phi_+} = 5.2910$ 22-1-15

This physical mechanism {(u$\bar{s}$) → Bose-Einstein condensate by galactic force → $(e\bar{e})$} proof that decay result of quark doublet of Kaon K^+ is appeared positron excess by curve of force lines. Only the force that stronger than color force (galactic force) can destroy quark-anti quark pair (u$\bar{s}$) to electron-positron pair $(e\bar{e})$. Therefore, observation results of AMS-2 are good evidence of Strong CP violation. The positron excess is valuable natural gift from neutronic seed novae as cosmic accelerator.

Same as Eq22-1-15 curve of force line between proton and electron is

$R_{peak} \equiv \frac{\Phi_-}{\Phi_+} = 6.545979 = \frac{g_{proton}}{g_{electron}}$ 22-2-20

Curve of force line of proton is

$g_{proton} = 6.545979$ 22-2-21

Curve of force line of electron is

$$g_{electron} = 1$$

Therefore, mass ratio between proton and electron is

$$R_{proton} = (\frac{1}{6.545979})^4 = \frac{1}{1836} = \frac{m_e}{m_p} = \frac{9.109534\times10^{-31}kg}{1.672648\times10^{-27}kg} \qquad 22\text{-}2\text{-}22$$

This result means that gravitational CP violation exist too.

Gravitational CP asymmetry of H_1^+ of universe is conserved by gravitational CP asymmetry of H_1^- of anti-verse (cf.§.13).

Because existence of anti-mass by AMS-2 measurement is proved,

Einstein's equivalence principle is became wrong principle.

Therefore, automatically curved space – time theory as Einstein's general theory of relativity is became wrong theory too.

Furthermore, AMS has found that the proton flux is characteristically different from all prior experimental results. The AMS measurement (figure 22-2-6) shows that the measured proton flux changes its behavior at ~300 GV rigidity. The solid line is a fit to the data. The dashed line is the proton flux expected with no change in behavior; it does not agree with the data at high energy.

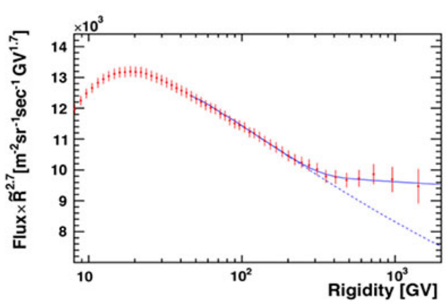


Figure 22-2-6

Most surprisingly, AMS has also found, based on 50 million events, that the helium flux exhibits nearly identical and equally unexpected behavior (Figure 22-2-7). AMS is currently studying the behavior of other nuclei in order to understand the origin of this unexpected change. These new observations will provide important insight into cosmic ray production and propagation.

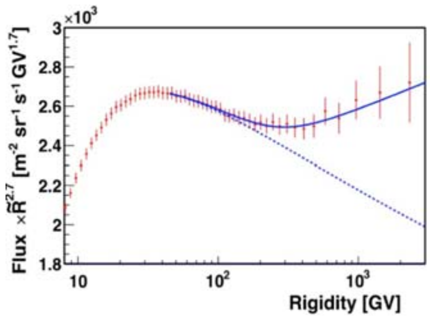


Figure 22-2-7

Such results should be same phenomena of positron excess through proton decay and doublet of quark's decay in AGNs and neutronic seed novae or quark novae by galactic force according to CFLE theory.

Because by such enough strong force can be broken color confinement and asymptotic freedom.

In conclusion, experiments of AMS-02 were successful. The origin of the excess positron fraction is inside of neutron of seed nova of neutron star and AGN, as in CFLE theory the dark matter effect comes from the curve of the force line inside of the neutron and proton. In other word, excess positron is emitted by gamma ray busters.

Why did the prediction of Moskalenko and Strong deviate from experiments? Simply put, the recent standard model for particle physics (which for lack of an alternative Moskalenko and Strong had no other choice but to employ for their calculation) is disqualified for researching general high-energy phenomena, because this model cannot include the generally applicable theory of general relativity, despite that quantum mechanics can generally apply to general particle physics.

The main culprit of such defect of the standard model is that the recent incalculable theory of general relativity as curved space–time theory is wrong as a metaphysical string theory. Consequently, the current standard model of particle physics is covered with inabilities and cannot be applied to any fields of physics theory.