Composite matter/antimatter hadron structure indicated at Texas Petawatt Laser Facility

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This presentation is an extension of prior work related to matter/antimatter space propulsion:

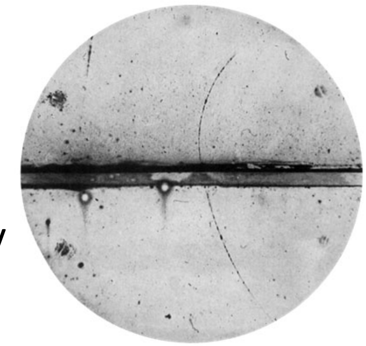
M. Pickrell, "Feasibility of a matter/anti-matter propulsion system for generating relativistic speeds in space," *J. Space Explor.* 9(2): 162-64 (May 10, 2020); DOI: 10.21767/2319-9822.1000162.

M. Pickrell, "Matter/Anti-Matter Propulsion," Propulsion Systems (Lingbao Li, ed.), IntechOpen Publishing, London, 2023; DOI: 10.5772/intechopen.110310.

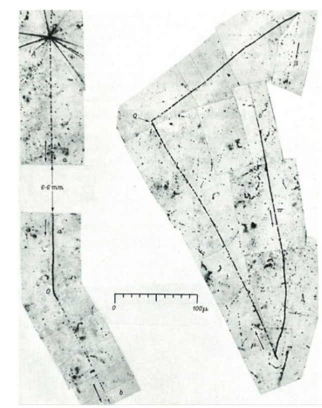
M. Pickrell, "Quantification of Electron/Positron Pairs for Matter/Antimatter Propulsion: Experimental Results & Next Steps," AIAA 2023-4731, AIAA Conference Paper, AIAA ASCEND Conference, Las Vegas, NV (Oct. 23-25, 2023); DOI: 10.2514/6.2023-4731.

Theoretical and Experimental Background -- Matter & Antimatter

- In 1928, Paul Dirac’s relativistic version of the Schrodinger wave equation recognizes solutions involving an antielectron; in 1930, Robert Oppenheimer proposed the existence of a “positively charged electron with the same mass”
- In 1932, Carl Anderson discovers positrons in cosmic rays; in 1936, Anderson describes electron/positron annihilation, crediting Joliot’s and Thibaud’s 1934 work on radioactive decay
- In 1934, Bethe & Heitler anticipate virtual electrons and positrons arising from the “quantum vacuum”
- In 1947, Cecil Powell, et al., discover pion, ultimately understood as a combination of a quark and antiquark, in particle collider
- In 1955, Owen Chamberlain and Emilio Segrè discover the antiproton at Berkeley Radiation Laboratory’s Bevatron
- In 1956, Bruce Cork, et al., discover the antineutron at BRL
- In 1964, Murray Gell-Mann and George Zweig theorize existence of quarks (as denominated by Gell-Mann)
- In 1964, James Cronin, Val Fitch, et al., discover CP violation for K meson decays



Positron



K meson to Π^+

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In 2008, Hui Chen and others at Lawrence Livermore National Laboratory discovered that "large quantities" of electron/positron pairs are generated when a high-intensity laser strikes a gold target (and can be separated magnetically)

Chen understood that the electron/positron pairs arise from the Bethe-Heitler quantum vacuum

Result conflicts with prediction of theory that electron/positron pairs arising from the quantum vacuum are very difficult (if not impossible) to separate

H. Chen, *et al*., "Relativistic positron creation using ultraintense short pulse lasers," *Phys. Rev. Lett*. **102**: 105001 (2009).

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Supposition: positrons exist within ordinary nuclei

Thought experiment: what would hadrons look like under the following parameters:

1. Gross universal matter/antimatter symmetry (as predicted from theory)
2. Matter/antimatter asymmetry at the subatomic scale (Cronin & Fitch)
3. Positrons may exist within ordinary stable nuclei (from H. Chen's results)
4. Protons, neutrons, and electrons exist as ordinary, observed hadrons

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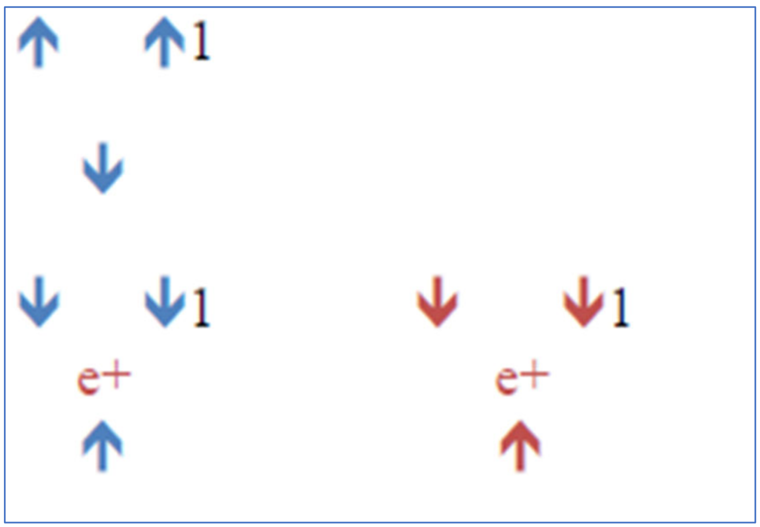
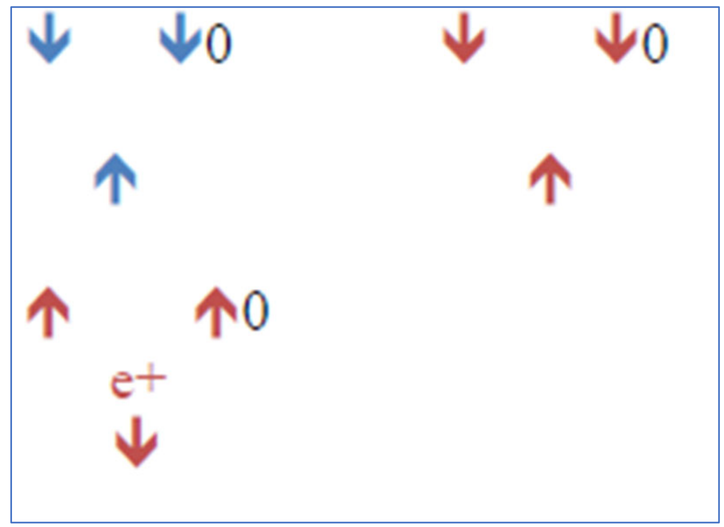
Hypothesis: Stable "ordinary" hadrons may be composed of quarks, antiquarks, and positrons

Composite proton structures:



Composite neutron structures:



Blue indicates matter; red indicates antimatter
Arrows indicate up or down quarks or antiquarks
e^+ = positron

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Prediction from Composite Hadron Hypothesis:

If the positrons generated when high-energy lasers strike a target arise internally from the nucleus, then the target should transmutate

In 2015, Alexander Henderson observed at the Texas Petawatt Laser Facility that gold targets struck by high-intensity lasers are transmutated in the process -- Au is transmutated into Pt

Therefore, the prediction from the Composite Hadron Model has been confirmed experimentally

*See "Sources" below for further details of Henderson's work

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Potential Implications of Composite Hadron Model, if Accepted

1. 4:1 H:He ratio likely initial atomic structure of Universe (correlates to observed ratios)
2. Proton-to-neutron conversion in proton-proton chain reactions is likely not caused by flavor change of quarks but, instead, positron ejection from protons
3. Neutrinos created as a byproduct of proton-proton chain reactions in stars likely cause the expansion, and the increasing rate of expansion, of the Universe
4. Beta decay (both *B*+ and *B*-) is likely an external, deterministic phenomenon caused by neutrinos interacting with nuclei

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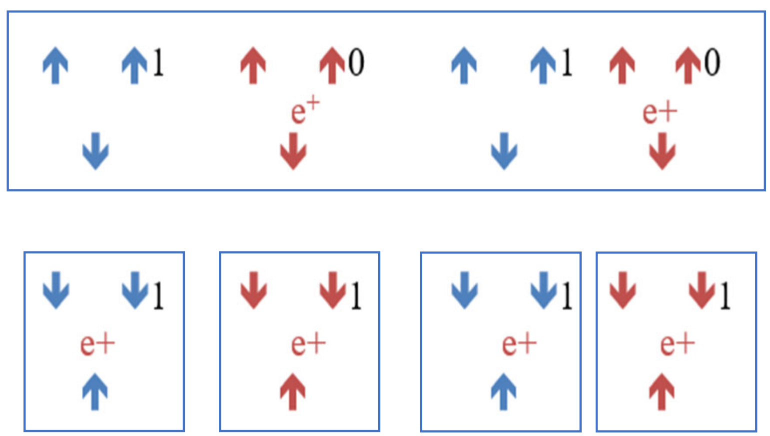
1. Initial Atomic State of the Universe

Equal numbers (in this case, six – the smallest repeatable unit) of up quarks, down quarks, up antiquarks, down antiquarks, electrons, and positrons, roughly reflect observed hydrogen/helium composition of stars:



= He

= 4 H

*electrons not shown

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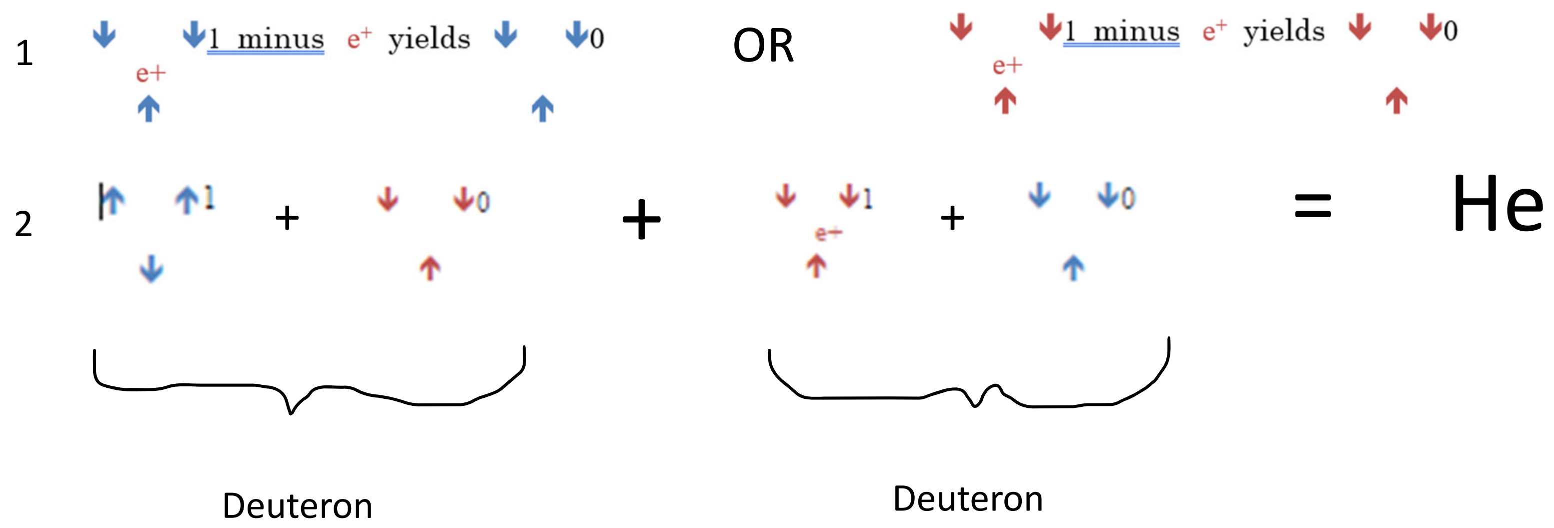
2. Proton-Proton Chain Reactions in Stars

Positrons are ejected from protons to form neutrons, which combine with protons to form deuterons, which combine to form helium nuclei



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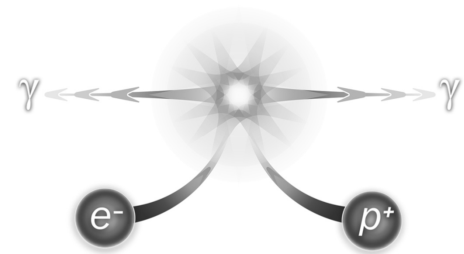
3. Expansion of the Universe

In proton-proton chain reactions in stars, positrons ejected from hydrogen nuclei encounter nearby electrons & annihilate



*p^+ = e+

1. Photons (511-keV gamma rays) and neutrinos are generated

2. Neutrinos, which have mass, accelerate to nearly *c* – expanding spacetime under the General Theory

3. If stars are increasingly active in the Universe, then the *rate* of expansion of the Universe will concomitantly increase

4. Neutrino acceleration is the best candidate for Dark Energy; neutrinos are the best candidate for the moiety of Dark Matter

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4a. Beta Decay (β+)

Within radioactive nuclei,

↓ ↓<u>1 minus</u> e^+ yields ↓ ↓0 , and the e^+ is emitted.

e+

↑ ↑

Similarly,

↓ ↓<u>1 minus</u> e^+ yields ↓ ↓0 , and the e^+ is emitted.

e+

↑ | ↑

Likely cause: proton in nucleus struck by neutrino, ejecting positron
Paradox of Schrodinger's Cat – apparently God does not
play dice with the Universe (pace, A. Einstein)

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4b. Beta Decay (β-)

Likely cause: neutrino, striking nucleus, lyses into electron & positron (reverse of electron/positron annihilation), depositing positron into neutron

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Composite Hadron Model Is Consistent With:

- Gross matter and antimatter symmetry in the Universe
- CP violation (i.e., matter and antimatter asymmetry) at the subatomic scale
- Presence of pions (and other antimatter quarks) in collider experiments
- Proton-proton chain reactions in stars
- Generation of positrons and e-/e+ magnetic separation in petawatt laser experiments
- Observed hydrogen/helium composition of stars
- Expansion of the Universe & the increasing rate of expansion of the Universe
- Beta decay (β+ and β-)
- Half-lives of radioactive isotopes as a 2nd-order kinetic
- Observed increasing half-lives of Voyager fission generator

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Potential for Even Greater Simplicity in the Composite Hadron Model – Pentaquarks and Tetraquarks

- Tetraquarks and Pentaquarks have been observed at the Large Hadron Collider

  - LHCb Collaboration, "Observation of $J/\Psi P$ resonances consistent with pentaquark state in $\Lambda \rightarrow J/\Psi K\text{-}\ p$ decays," *Phys. Rev. Lett*. **115**: 072001 (2015).
  - LHCb Collaboration, "Observation of an exotic narrow doubly charmed tetraquark," *Nat. Phys*. **18**: 751-54 (2022).

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Simplified Composite Hadron Structure

- Because total positive quark & antiquark charge in initial atomic state (slide 9) is 6, and the total negative quark & antiquark charge in initial atomic state is 6 (which match the positive 6 and negative 6 charges of the electrons and positrons), it is likely that the distinction of up and down quarks & antiquarks is misplaced
- May be better to think fundamentally of positive quarks and negative quarks each with 1/3 of the charge of an electron or positron (equal to currently-understood down quark and down antiquark)
- Stable pentaquark and tetraquark matter/antimatter structure of hadrons is likely, sometimes with positrons included in the hadron conformation

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Next Steps:

1. Further experimental testing/verification is called for
2. Implications of composite hadron structure should be evaluated:
   a. Revisit prior collider results (e.g., Bevatron results – see adjacent)
   b. Mathematically address apparent presence of positrons within hadrons
   c. Further evaluate cosmological effect of composite hadron structure on evolution of the Universe (particularly early, hot Universe)
   d. Mathematically address possibility of quarks/antiquarks as simply positive & negatively charged fundamental particles (charge = +1/3 or -1/3) forming stable pentaquark and tetraquark hadrons (sometimes conjoined with a positron); i.e., *currently-understood down quark and down antiquark are the fundamental building blocks, along with positrons, of hadrons in the Universe*

Proton/Neutron Bevatron collision -- demonstrated existence of antiproton

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Thank You!

Please address questions, comments, criticism to:

mark.pickrell@albireoscientific.net

Working paper: https://hal.science/hal-04261243/document

An updated version of this working paper is exclusively under consideration at *Physics Essays*, currently in post-peer-review process

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Sources

Images

1. “Positron”: https://%3A%2F%2Fi.pinimg.com%2Foriginals%2F27%2Fc9%2Fd4%2F27c9d4d46dc9f37b5ce522ea42bd61f0.jpg

2. “K meson to ∏+”: https://www.cloudylabs.fr/wp/kaoninteractions/

3. “Proton/Antiproton Bevatron collision”: https://indico.cern.ch/event/104466/attachments/15569/22575/The_Bevatron.pdf

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Sources

Select Publications

1. H. Bethe & W. Heitler On the stopping of fast particles and on the creation of positive electrons, *Proc. Roy. Soc. A* **146**: 83 (1934).

2. O. Chamberlain, E. Segrè, C. Wiegand, and T. Ypsilantis, Observation of antiprotons, *Phys. Rev.* 100: 947-50 (October 24, 1955).

3. H. Chen, *et al.*, "Relativistic positron creation using ultraintense short pulse lasers," *Phys. Rev. Lett*. **102**: 105001 (2009).

4. J.H. Christenson, J.W. Cronin, V.L. Fitch, and R. Trulay, Evidence for the 2Π Decay of the K_2^0 Meson. *Phys. Rev. Lett*. **13**(4): 138-40 (July 27, 1964).

5. LHCb Collaboration, "Observation of $J/\Psi P$ resonances consistent with pentaquark state in $\Lambda \rightarrow J/\Psi K- p$ decays," *Phys. Rev. Lett*. **115**: 072001 (2015).

6. LHCb Collaboration, "Observation of an exotic narrow doubly charmed tetraquark," *Nat. Phys*. **18**: 751-54 (2022).

7. S. Mertens, Direct neutrino mass experiments, *J. Phys. Conf. Series* **718** (2): 022013 (2016)

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Sources

Henderson
Dissertation

With Permission of Dr. Henderson

A.H. Henderson, “Monte-Carlo simulation and measurements of electrons, positrons, and gamma-rays generated by laser-solid interactions,” Rice University, Houston Texas (January 2015) (doctoral dissertation)(Section 5.4 discusses transmutation observation)

Henderson’s dataset: DOI//10.6084/m9.figshare.24319894

Henderson’s comparator:
https://www.nndc.bnl.gov/nudat3/getdataset.jsp?nucleus=196Pt&unc=nds

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