Sexaquark Dark Matter

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6-quark, Q=0, B=2
Spin-0, scalar
Flavor singlet

Uniquely among hadrons, Fermi statistics is compatible with being symmetric in space and totally antisymmetric (singlet) in:

- color
- flavor
- spin

(Most-Attractive Channel)³

Hypothesis: S is stable and spatially compact

$M_S \lesssim 2 m_p$

This is compatible with all experiments and theory.  

Eludes detection in accelerators because:

- neutrons are similar and $10^6 \times$ more abundant
- small wfn overlap $\Rightarrow$ hard to produce or destroy.

OK with direct detection expts  

Same quark content as H-dibaryon* (Jaffe 1977), but different physics:
not a loosely bound di-$\Lambda$!  *mass $\sim 2150$ MeV in bag model $\Rightarrow$ decays in $10^{-10}$ s

GRF 1708.08951

Mahdawi+GF1804.03073
DM to baryon ratio follows from stat mech, quark masses & temperature of QGP-hadronization transition.

Prediction is correct AND accurate to \( \sim 20\% \), for entire range of \( M_S \) and \( T_{QCD} \).

\[
\frac{\Omega_{DM}}{\Omega_b} = \frac{y_b \kappa_s 3 f_s}{1 - \kappa_s 3 f_s}
\]

\[
\kappa_s(m_S, T) = \frac{1}{1 + (r_{\Lambda, \Lambda} + r_{\Lambda, \Sigma} + 2r_{\Sigma, \Sigma} + 2r_{N, \Xi})}
\]

\[
r_{1,2} \equiv \exp[-(m_1 + m_2 - m_S)/T]
\]

\[
\frac{\Omega_{DM}}{\Omega_b} \text{ obs} = 5.3 \pm 0.1
\]

Prediction also applies to strange quark nuggets & PBH…

\( m_u = 2.118(38) \) MeV
\( m_d = 4.690(54) \) MeV
\( m_s = 92.52(69) \) MeV

GRF, hep-ph:1805.03723
S dark matter explains primordial $^7\text{Li}$

(GRF + R. Galvez, in preparation)

The “action” is at $T \sim 80$ keV
$\Rightarrow$ only loosely bound $^7\text{Li}$ & $^7\text{Be}$ are affected

S breaks up $^7\text{Li}$ & $^7\text{Be}$ reducing predicted abundance

CDM prediction for $^7\text{Li}$ is $10\sigma$ above obs.; destruction by S removes the excess

**KE** threshold for breakup
- $^7\text{Be}$ 1.58 MeV
- $^7\text{Li}$ 2.46 MeV
- $^3\text{He}$ 4.47 MeV
- $^3\text{H}$ 5.75 MeV
- $^4\text{He}$ 19.3 MeV

[d, 2.2 MeV, replenished]