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## Dynamics of quarks and gauge fields in the lowest-energy states in QCD and QED

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We examine the dynamics of quarks and gauge fields in QCD and QED interactions in the lowest energy states with approximate cylindrical symmetry, in a flux tube model. Using the action integral, we separate out the (3+1)D in terms of the transverse and the longitudinal degrees of freedom and solve the resultant equations of motion. We find that there may be localized and stable states of QCD and QED collective  $q\bar{q}$  excitations, showing up as particles whose masses depend on the QCD and QED coupling constants and the flux-tube radius [1]. Along with known standard stable collective QCD excitations of the quark-QCD-QED system, there may be stable QED collective  $q\bar{q}$  excitations, which can be good candidates for the X17 particle [2], the E38 particle [3], and anomalous soft photons [4,5] observed recently in the region of many tens of MeV, as discussed in [6].

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[1] A. Koshelkin and C. Y. Wong, *Open string QED meson description of the X17 particle and dark matter*, JHEP 08 (2020) 165, [arxiv:2001.04864].

Dynamics of quarks and gauge fields in the lowest-energy states in QCD and QED, arxiv:2111.14933.

\vspace\*{0.3cm}

[2] A. J. Krasznahorkay *et al.*, *Observation of anomalous internal pair creation in  $^8\text{Be}$ : a possible indication of a light, neutral boson*, Phys. Rev. Lett. 116, 042501 (2016), [arXiv:1504.01527].

\vspace\*{0.3cm}

[3] K. Abraamyan, *et.al.*, *Check of the structure in photon pairs spectra at the invariant mass of about 38 MeV*, EPJ Web of Conferences 204, 08004 (2019).

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[4] A. Belogianni *et al.* (WA102 Collaboration), *Observation of a soft photon signal in excess of QED expectations in  $pp$  interactions*, Phys. Lett. B548, 129 (2002).

\vspace\*{0.3cm}

[5] J. Abdallah *et al.* (DELPHI Collaboration), *Evidence for an excess of soft photons in hadronic decays of  $Z^0$* , Eur. Phys. J. C47, 273 (2006), [arXiv:hep-ex/0604038].

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[6]

C. Y. Wong, *Open string QED meson description of the X17 particle and dark matter*, JHEP 08 (2020) 165, [arxiv:2001.04864].

### In-person participation

Yes

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