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Cosmological limitations on the mass of neutral leptons.
 In connection with the discovery of the charged lepton, it
 is shown that cosmological considerations limit the mass

of the corresponding neutrino to a value less than 30 eV.

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 26, 200 (1977) [JETP Lett. 26, 188 (1977)].

M. A. Shifman. *Charmonium and asymptotic free-*
dom. We are witnessing the development of a new had-

$$\alpha_s(r) \sim \frac{1}{\ln(r_0/r)} \quad (1)$$

ron theory. Dubbed quantum chromodynamics, this is
 a renormalizable theory of the Yang-Mills type, in which
 the interaction is realized by an octet of massless vec-

tor gluons connected with the color degrees of freedom
 of the quarks. A unique property of quantum chromo-

$$\alpha_s(m_c) \approx 0.2, \quad (2)$$

dynamics is a logarithmic decrease of the coupling con-

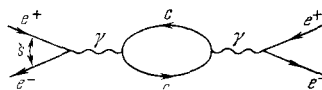


FIG. 1.

stant α_s over small distances^[1]

The unlimited growth of the constant at large distances
 gives grounds for hoping that all the objects with non-

zero color charge (quarks, diquarks, gluons, etc.) have
 infinite mass, so that the physical sector of the theory
 covers only colorless states. It must be emphasized
 that despite the noticeable progress, color confinement
 has not yet been proved, and no quantitative approach
 to the problem of large distances has been developed
 in chromodynamics (as already mentioned in Polyakov's
 paper).

$$\int \frac{ds}{s^n} \sigma(e^+e^- \rightarrow \text{charm}) = 4\pi^2 Q_c^2 \alpha^2 \frac{A_n}{(4m_c^2)^n} \quad (n=1, 2, \dots), \quad (3)$$

Whereas the theoreticians' attack on this flank of the
 theory is still tactical, strong positions have been won
 on another flank, in the region of short distances. The
 logarithmic exclusion of the interaction (1), dubbed
 asymptotic freedom, has explained qualitatively a large
 number of phenomena connected with deep-inelastic
 processes.^[2] A large number of quantitative corollaries
 was obtained after the discovery of the Ψ family of par-

$$\Gamma(\Psi \rightarrow e^+e^-) = \frac{\alpha^2}{\pi} \cdot \frac{2^{11} \cdot 11^3}{3^7 \cdot 5^4 \cdot 7} m_\Psi = 5 \text{ keV}. \quad (4)$$

ticles. Being made up of heavy charmed quarks $c\bar{c}$,
 these particles (now usually designated by the term
 "charmonium") annihilate into ordinary hadrons over
 distances on the order of the Compton wavelength of the
 c -quark. At these distances, the effective coupling con-

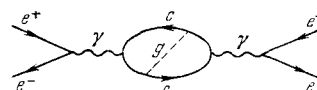


FIG. 2.