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LOOKING FOR A LIGHT HIGGS BOSON IN $\phi$ AND $\psi$
RADIATIVE DECAYS
We also extend our considerations to the analogous radiative decay. We find the branching ratio of this process should be of interest to a radiative decay, using a vector meson dominance approach. The result of this work is the possibility of producing a light Higgs boson in the $\phi$ decay.

Abstract

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Looking for a Light Higgs Boson in $\phi$ and $\phi^*$ Radiative Decays
\[(\phi_{\text{\tiny 1}} \oplus \phi_{\text{\tiny 2}}) \oplus (\phi_{\text{\tiny 3}} \oplus \phi_{\text{\tiny 4}}) \oplus (\phi_{\text{\tiny 5}} \oplus \phi_{\text{\tiny 6}}) = \phi_{\text{\tiny 7}}\]

\[\text{This represents a condition for the quantum state.}\]

\[\phi_{\text{\tiny 1}} \oplus \phi_{\text{\tiny 2}} \oplus \phi_{\text{\tiny 3}} \oplus \phi_{\text{\tiny 4}} \oplus \phi_{\text{\tiny 5}} \oplus \phi_{\text{\tiny 6}} = \phi_{\text{\tiny 7}}\]

\[\text{From the above state, this gives:}\]

\[\text{An expression of the amplitude, which is particularly convenient to the subsequent}\]

\[\phi_{\text{\tiny 1}} \oplus \phi_{\text{\tiny 2}} + \phi_{\text{\tiny 3}} + \phi_{\text{\tiny 4}} + \phi_{\text{\tiny 5}} + \phi_{\text{\tiny 6}} + \phi_{\text{\tiny 7}} = \phi_{\text{\tiny 8}}\]

\[\text{Where this equation is given by:}\]

\[\phi_{\text{\tiny 1}} \oplus \phi_{\text{\tiny 2}} \oplus \phi_{\text{\tiny 3}} \oplus \phi_{\text{\tiny 4}} \oplus \phi_{\text{\tiny 5}} \oplus \phi_{\text{\tiny 6}} = \phi_{\text{\tiny 7}}\]

\[\text{We define the transition amplitude for the radiative process}\]

\[\text{A qualitative estimate for the angular correction to the Higgs production and decay matrix elements, which are not reproduced in the standard model,}\]

\[\text{Recent measurements of the Higgs production and decay matrix elements, which are not reproduced in the standard model,}\]

\[\text{In order to obtain the minimal version of the standard model, making use of the minimal model,}\]

\[\text{This could be studied by the two-body radiative decay,}\]

\[\text{We would like to point out that a sequential process in this context might}\]

\[\text{In this situation it is important to examine as many different processes as possible.}\]

\[\text{A variety of processes have been been particularly vulnerable to searches for the Higgs boson, and the resulting experimental hints have been}\]

\[\text{Very high Higgs boson}\]

\[\text{Considerable attention has been given recently to the question of the existence of a}\]
\[ (13) \quad 0 = \varepsilon \phi^0 \phi^0 = \varepsilon b \left( \frac{y}{V} \right)^2 \left( \frac{d}{d \theta} \right)^2 - \left( 0, 0, 0, \phi \right) \varepsilon \]

Correspondingly:

believe like \( \gamma \) which imply that if \( 0 = \varepsilon \phi \)
and the conditions \( \gamma \phi \) must satisfy \( \left( x^2 + b^2 \right)^{1/4} \gamma \phi \):
Since \( \gamma \phi \) should be finite, the amplitude \( \gamma \phi \) must be
\( (12) \quad \left( \varepsilon \gamma^b \phi \right) \varepsilon \left( \frac{y}{d \phi} \right) - 1 = \left( \varepsilon \gamma^b \phi \right) \varepsilon \]

To get rid of the apparent singularity at \( \gamma \phi \) this follows from \( \gamma \phi \) which

To be \( \gamma \phi \) the final result at \( b \phi \)

\( (11) \quad \left[ \frac{(d^2 b)}{(d^2 \phi)} \right] (d \phi) \left( \frac{d}{d \phi} \right) \left( \frac{y}{d \phi} \right) \left( \frac{y}{d \phi} \right) \gamma \phi \varepsilon \)

Further important current conservation:

\( \left( \varepsilon \gamma^b \phi \right) \varepsilon \gamma \phi \varepsilon \)

where we have defined \( \gamma \phi \) orthogonal to \( \gamma \phi \) and

\( (6) \quad \left[ (\phi \leftrightarrow \phi) + (\gamma \phi \phi \phi - \gamma \phi \phi \phi) (\gamma \phi) \right] \varepsilon \) +

\[ \left[ (\phi \leftrightarrow \phi) + (\gamma \phi \phi \phi - \gamma \phi \phi \phi) \right] \varepsilon \] +

\[ \left[ (\gamma \phi \phi \phi - \gamma \phi \phi \phi) \right] \varepsilon \]

The result is:

\( (8) \quad 0 = \varepsilon \gamma \phi \varepsilon \gamma \phi \varepsilon \)

and expand the tensor into invariant subject to the conditions

\( (7) \quad \varepsilon \left( \gamma^b \phi \right) \left( \frac{d}{d \phi} \right)^2 \left( \gamma^b \phi \right) \varepsilon \phi \)

For the contribution of the \( \phi \) term we start from:

Thus the amplitude of interest in eq. (7) is split according to \( \gamma \phi \) into two components

\( (9) \quad \gamma = \frac{\gamma^b \phi}{\gamma^b \phi - \gamma^b \phi} = \gamma^b \phi \)
\[ (2) \quad \langle (u', d')|\phi|(0)\phi b\rangle (y', b)\phi = (0, 1\phi, 1\phi\phi' | \phi (u') \rangle \]

\[ (16) \quad \theta_{\gamma}^{\phi} = \frac{\theta_{\gamma}^{\phi}}{\theta_{\gamma}^{\phi} + \delta} \sqrt{\frac{(d|GZ|\lambda)^{\psi}}{\theta_{\gamma}^{\phi}}} - \theta_{\gamma}^{\psi} \]

\[ (18) \quad \langle (u', d')|\phi|(0)\phi b\rangle \langle 0| (0)| (x, w, \ell) \rangle \langle 0| \rangle > \]
to be of the order of 20-30%.

The photon mass ghost. On pronouncing the ghost's name down to the dominant conjugate, related to the expropriation from the vector mass, we can expect such an uncertainty as long as we, m. Also, they are subject to the logical uncertainity of the vector mass. (9) and (20) depend rather weakly on the values of the current quark masses.

(29)

\[ \Phi \rightarrow \phi \]

Rephrasing ey's (28) into eq. (2) we obtain for the Higgs boson mass resembling from 0 where we need (16) and (20) in eqs. (2), (6) and (9) in eqs. (2)

(28)

\[ \left[ \frac{\mu^2 - \mu}{\alpha_2} \left( \frac{M_H^2 - \mu^2}{\alpha_2} \right) + \frac{\mu^2}{\alpha_2} \right] \frac{\mu^2}{\alpha_2} + \frac{1}{\alpha_2} (\beta \alpha \gamma \lambda) \phi \]

\[ \approx \delta \]

Preliminary assembling eqs. (10) and (27) we find for the mass splitting (29) and (32) and inserting them into eqs. (20), (21) and (22) we obtain after comparing the vector operator contribution to the decay amplitude at \( \gamma = \mu \).

(27)

\[ \frac{\mu^2 - \mu}{\alpha_2} \left( \frac{M_H^2 - \mu^2}{\alpha_2} \right) \frac{\mu^2}{\alpha_2} + \frac{1}{\alpha_2} (\beta \alpha \gamma \lambda) \phi = \langle 0 | \Phi \rangle \]

Collecting eqs. (26) and (27) and inserting them into eqs. (20) one can easily derive the relation to the mass splitting among the vector meson and the Higgs boson. In this way we have the basic, d 's quark triplet. Then with the OZI rule suggests

(20)

\[ \Phi \rightarrow \phi \]

Thus taking as \( \phi \) the basic, d 's quark triplet. Then, with the OZI rule suggests

(23)

\[ \frac{\phi}{\sqrt{m}} = \frac{1}{\sqrt{m}} \]

(9) and (20) (and \( \phi^2 = \phi^2 \))

(22)

\[ \Phi \rightarrow \phi \]

\[ \frac{\phi}{\sqrt{m}} = \frac{1}{\sqrt{m}} \]

\[ \phi \frac{\phi}{\sqrt{m}} = \frac{1}{\sqrt{m}} \]

where \( \phi^2 = \phi^2 \)

(22)

\[ \Phi \rightarrow \phi \]

\[ \frac{\phi}{\sqrt{m}} = \frac{1}{\sqrt{m}} \]

\[ \phi \frac{\phi}{\sqrt{m}} = \frac{1}{\sqrt{m}} \]

To make an estimate of the matrix element in eq. (21) we first write HSB in terms of SV (3)
\[
\begin{align*}
(32) & \quad \left[ \frac{2m}{2} + \frac{20}{12} \right] \frac{\phi m}{\Delta f} \frac{1}{(p_{\Delta G}^2 + 1)^{\frac{1}{2}}} \approx \mathcal{G} \\
(33) & \quad \text{BR}(\gamma \to \phi/\gamma) \\
\end{align*}
\]

Thus finally eq. (28) turns into:

\[
\text{BR}(\gamma \to \phi/\gamma) \approx m_{\gamma} m_{\phi}
\]

Consequently, assume the value:

practice \( p_{\Delta G} \approx \frac{m_{\phi}}{m_{\gamma}} \approx \frac{\gamma}{m_{\gamma}} \) for the latter operator matrix element we may rather

\[
\begin{align*}
0^+ & \rightarrow 0^+ \text{ which is now determined by the bare chargin mass squared} \text{ with the decay mass squared}
\end{align*}
\]

whereas the only modification comes from the graph term unmodified from the case of the

\[
\begin{align*}
\text{The estimate of the contribution from the graph term of eq. (4) remains the interval integer.

\end{align*}
\]

To this purpose we evaluate the ratio to the sum

\[
\begin{align*}
\text{interleaved correction for } J/\gamma \rightarrow \phi/\gamma
\end{align*}
\]

one can necessarily extract these corrections to the case of the \( J/\gamma \)'s, and into a graph-

\[
\begin{align*}
\text{for } m_{\gamma} \rightarrow m_{\phi}, \text{as has been recently reviewed in ref. (34).}
\end{align*}
\]

\[
\begin{align*}
\text{subset of the Higgs decay modes and therefore within the minimal background.

\end{align*}
\]

The Higgs boson would receive instead of a monochromatic photon, a bremsstrahlung iden-

\[
\begin{align*}
\text{order of magnitudes should be achieved.

\end{align*}
\]

\[
\begin{align*}
\text{should not necessarily be significant to the planar-factors, where the

\end{align*}
\]

\[
\begin{align*}
\text{size of such an effect is anyhow somewhat limited by the

\end{align*}
\]

\[
\begin{align*}
\text{for eq. (28) can arise,'}
\end{align*}
\]

\[
\begin{align*}
\text{with } m_{\phi} \text{ and } m_{\gamma} \text{ the width of a Higgsphoton subject scalar resonance. In this

\end{align*}
\]

\[
\begin{align*}
\left( \frac{m_{\gamma}}{m_{\phi}} + 1 \right)^{\frac{1}{2}} \approx (\gamma m_{\phi})_{\text{sinewk}}
\end{align*}
\]

\[
\begin{align*}
\text{simplest possibility for such a factor should be:

\end{align*}
\]

\[
\begin{align*}
\text{In principle we might multiply Eq. (28) by a Breit-Wigner factor

\end{align*}
\]
for the Higgs boson mass ranging between 0 and 1.5 GeV.

This estimate should be taken as simply a qualitative order of magnitude indication, since the application of the vector meson dominance approach to the J/ψ should be much more uncertain than for the previous case of the φ. Such an uncertainty might amount to a factor of two in the present case. Nevertheless, the values used in eq. (33) should still be significant, specially considering that the scale m_w used in eq.(32) could represent an underestimate. Indeed if we used there m_W instead of m_Z, then the value in eq.(33) would be enhanced by roughly a factor of five. Also, the one-loop QCD corrections [12,13] are not applicable in the present case of the J/ψ because the one-loop QCD corrections [12,13] are not

In conclusion, we find branching ratios of the order of 10^{-6} for J/ψ → χ_H and of the

order of 10^{-5} for J/ψ → γH. Although small, these rates should be in the reach of the

planned φ and J/ψ factories.

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