In $\gamma\gamma \to 4\pi$ near the $\rho\rho$ threshold, TASSO (BRANDELIK 80B, ALTHOFF 82), MARK2 (BURKE 81), CELLO (BEHREND 84E), PLUTO (BERGER 88B), SLAC TPC (AIHARA 88), and ARGUS (ALBRECHT 91F) observe a resonance-like structure. This is dominated by $\rho^0\rho^0$, and the cross section peaks a little above the $f_2(1520)$. This process has not been explained by models in which only conventional resonances dominate. The fact that the $\gamma\gamma \to \rho^+\rho^-$ is small (ALBRECHT 91F quotes 1/4 for the $\rho^+\rho^-/\rho^0\rho^0$ ratio) requires both isospin 0 and 2 for the $\rho\rho$ system. A resonance interpretation in terms of $q^2\overline{q}^2$ states thus requires the presence of a flavor exotic $I = 2$ resonance (ACHASOV 82, 87, 90). For this $\rho\rho$ structure, the 2^{++} partial wave is found to be dominant (BERGER 88B, ALBRECHT 91F), with some 0^{++} at the low-energy end, while $J^P = 0^-$ and 2^- contribute very little.

In $\gamma\gamma \to \omega\rho$, there is also a broad enhancement that peaks near 1.6 GeV (BEHREND 91, WEGNER 91), which is probably composed of several spin parities (BEHREND 91).

Other exotic or non-$q\overline{q}$ candidates: An isovector $\phi\pi^0$ resonance at 1480 MeV has been reported by BITYUKOV 87 in $\pi^- p \to \phi\pi^0 n$; see the $\rho(1450)$. Preliminary indications favor $J^{PC} = 1^{--}$, *i.e.* nonexotic, but the large OZI-rule violating branching ratio $\phi\pi{:}\omega\pi$ seems peculiar for a $(u\overline{u}\text{-}d\overline{d})$ $I = 1$ $q\overline{q}$ object. However, ACHASOV 88 shows that the threshold effect from the two-step process $\rho(1600) \to K\overline{K}^* \to \pi\phi$ can violate the rule, especially near threshold. No sign of this candidate is seen in $\pi\omega$ (FUKUI 91). In addition, the small coupling to the photon makes an identification with the $\rho(1450)$ difficult (CLEGG 88). More recently DONNACHIE 93, analyzing e^+e^- annihilation and diffractive photoproduction data, suggests there may be 4-quark states near 1100 and 1300 MeV.

Another exotic candidate is the $\hat{\rho}(1405)$ (ALDE 88B, IDDIR 88), seen in the GAMS experiment under the $a_2(1320)$ in $\pi^- p \to \eta\pi^0 n$ with the exotic quantum numbers $J^{PC} = 1^{-+}$. Although the forward-backward asymmetry demands an $\eta\pi$ P-wave, it may be due to a nonresonant amplitude. The Crystal Barrel collaboration has reported results on the corresponding P-wave in $\eta\pi$ seen in $p\overline{p} \to \eta\pi\pi$; they see a much broader effect, which can be explained as nonresonant or as a resonance with $\Gamma \approx 600$ MeV. AOYAGI 93 also notes the $\eta\pi$ P-wave, but its interpretation is unclear.

For another possible 1^{-+} candidate, see the isosinglet $X(1910)$.

A narrow resonance, listed under $K_J^?(3100)$, has been reported at about 3100 MeV (BOURQUIN 86, ALEEV 93) in several $\Lambda\overline{p}$ + pions and $\overline{\Lambda}p$ + pions states. The observation of the doubly charged states $\Lambda\overline{p}\pi^-$ and $\overline{\Lambda}p\pi^+$ implies, assuming the decay is strong, $I = 3/2$, clearly not a $q\overline{q}$ state. In addition, a narrow peak is observed at about 3250 MeV, listed under $X(3250)$, in the "hidden strangeness" combinations containing a baryon-antibaryon pair (ALEEV 93). However, all these observations need confirmation.

Non-$q\overline{q}$ Candidates

OMITTED FROM SUMMARY TABLE

NON-$q\overline{q}$ CANDIDATES REFERENCES

TORNQVIST 94 ZPHY C61 525 Tornquist (HELS)
BALI 93 PL B309 378 +Schilling, Hulsebo, Irving, Michael+ (LIVP)
DONNACHIE 93 ZP C60 187 +Kalashnikova, Clegg (BNL)
ERICSON 93 PL B309 426 +Karl (CERN)
GEIGER 93 PR D47 5050 +Isgur (TNTO)
MANOHAR 93 NP B399 17 +Wise (MIT)
MORGAN 93 PR D48 1185 +Pennington (RAL, DURH)
ZOU 93 PR D48 R3948 +Bugg (LOQM)
APSIMON 92 ZPHY C56 185 +Atkinson+ (Omega Photon Collab.)
BARNES 92 PR D46 131 +Swanson (ORNL)
BARTELSKI 92 PL B289 429 +Tatur+ (WARS)
DOOLEY 92 PL B275 478 +Swanson, Barnes (ORNL)
LINDENBAUM 92 PL B274 492 +Longacre (BNL)
SWANSON 92 ANP 220 73 (ORNL)
AKER 91 PL B260 249 +Amsler, Peters+ (Crystal Barrel Collab.)
ALBRECHT 91F ZPHY C50 1 +Appuan, Paulini, Funk+ (ARGUS Collab.)
BEHREND 91 ZPHY C49 401 +Criegee, Field, Franke+ (CELLO Collab.)
BEHREND 91D PL B257 505 +Bussey, Ahme, Apel+ (CELLO Collab.)
CHEN 91 Hadron 91 Conf. (Mark III Collab.)
SLAC-PUB-5669
CONDO 91 PR D43 2787 +Handler+ (SLAC Hybrid Collab.)
DOVER 91 PR C43 379 +Gutsche, Faessler (BNL)
FUKUI 91 PL B257 241 +Horikawa+ (SUGI, NAGO, KEK, KYOT, MIYA)
MORGAN 91 PL B258 444 +Pennington (RAL, DURH)
MORGAN 91B Hadron 91 Conf. +Pennington (RHEL)
RAL-91-070
TORNQVIST 91 PRL 67 556 (HELS)
WEGNER 91 ZPHY C48 393 +Olsson, Allison, Ambrus (JADE Collab.)
ACHASOV 90 TF 20 (178) +Shestakov (NOVO)
BREAKSTONE 90 ZPHY C48 569 + (ISU, BGNA, CERN, DORT, HEIDH, WARS)
BURNETT 90 ARNPS 46 332 +Sharpe (RAL)
CALDWELL 90 Hadron 89 Conf. p 127 (UCSB)
GOUNARIS 90 NP B346 84 +Paschalis+ (THES)
LONGACRE 90 PR D42 874 (BNL)
TORNQVIST 90 NPBPS 21,196 (HELS)
WEINSTEIN 90 PR D41 2236 +Isgur (TNTO)
ARMSTRONG 89B PL B221 221 +Benayoun+(CERN, CDEF, BIRM, BARI, ATHU, CURIN+)
ARMSTRONG 89D PL B227 186 +Benayoun (ATHU, BARI, BIRM, CERN, CDEF)
MAY 89 PL B225 450 +Duch, Heel+ (ASTERIX Collab.)
WEINSTEIN 89 UTPT 89 03 +Isgur (TNTO)
AIHARA 88 PR D37 28 +Alston, Avery, Barbaro-Galtieri+ (TPC-2γ Collab.)
ALDE 88B PL B205 397 +Binon, Bouteumeur+ (SERP, BELG, LANL, LAPP)
ASTON 88D NP B301 525 +Awaji, Bienz+ (SLAC, NAGO, CINC, INUS)
BERGER 88B ZPHY C38 521 +Klovning, Burger+ (PLUTO Collab.)
BIRMAN 88 PRL 61 1557 +Chung, Peaslee+ (BNL, FSU, IND, MASD)
CLEGG 88 ZPHY C40 313 +Donnachie (MCHS, LANC)
ETKIN 88 PL B201 568 +Foley, Lindenbaum+ (BNL, CUNY)
GOUNARIS 88 PL B213 541 +Neufeld (CERN)
IDDIR 88 PL B205 564 +Le Yaouanc, Ono+ (ORSAY, TOKY)
SHOEMAKER 88 PR D37 1120 +Ko, Michael, Lander, Pellet+ (UCD)
SLAUGHTER 88 MPL A3 1361 (LANL)
TOKI 88 AIP Conf. (SLAC)
TUAN 88 PL B213 537 +Ferbel, Dalitz (HAWA, ROCH, OXFTP)
ACHASOV 87 ZPHY C36 161 +Karnakov, Shestakov (NOVO)
ALDE 87 PL B198 286 +Binon, Bricman+ (LANL, BRUX, SERP, LAPP)
ALDE 87B ZPHY C36 603 +Binon, Bricman+ (LANL, BELG, SERP, LAPP)
ASTON 87 NP B292 693 +Awaji, D'Amore+ (SLAC, NAGO, CINC, INUS)
AU 87 PR D35 1633 +Morgan, Pennington (DURH, RAL)
BITYUKOV 87 PL B188 383 +Dzhelyadin, Dorofeev, Golovkin+ (SERP)
CHANOWITZ 87 PL B187 409 (LBL)
CLOSE 87 RPP 51 833 (RHEL)
AKESSON 86 NP B264 154 +Albrow, Almehed+ (Axial Field Spec. Collab.)
ALDE 86D NP B269 485 +Binon, Bricman+ (BELG, LAPP, SERP, CERN)
ANDO 86 PRL 57 1296 +Imai+ (KEK, KYOT, NIRS, SAGA, INUS, TSUK+)
BISELLO 86 PL B179 289 +Busetto, Castro, Limentani+ (DM2 Collab.)
BOURQUIN 86 PL B172 113 +Brown+ (GEVA, RAL, HEIDP, LAUS, BRIS, CERN)
COOPER 86 Berkeley Conf. 67 (MIT)
DOVER 86 PRL 57 1207 + (BNL)
HEUSCH 86 Seewinkel Symposium on Multiparticle Dynamics (SLAC)
MESHKOV 86 Aspen Winter Conf. (NBS)
CHUNG 85 PRL 55 779 +Fernow, Boehnlein+ (BNL, FLOR, IND, MASD)
ISGUR 85 PRL 54 869 +Kokorski, Patou (TNTO)
LEYAOUANC 85 ZPHY C28 309 +Olivek, Pene, Raynal, Ono (ORSAY)
AU 84 PL 167B 229 +Morgan, Pennington (RL)
BEHREND 84E ZPHY C21 205 +Achenberg, Deboer+ (CELLO Collab.)
BINON 84C NC 80A 363 +Bricman, Donskov+ (BELG, LAPP, SERP, CERN)
DOVER 84 PL 146B 103 (ORSAY)
BINON 83 NC 78A 313 +Donskov, Duteil+ (BELG, LAPP, SERP, CERN)
CHANOWITZ 83 PL 126B 225 +Sharpe (UCB, LBL)
WEINSTEIN 83B PR D27 588 +Isgur (TNTO)
ACHASOV 82 PL B108 134 +Devyanin, Shestakov (NOVO)
AIHARA 82 PR D37 28 +Alston, Avery, Barbaro-Galtieri+ (TPC Collab.)
ALTHOFF 82 ZPHY C16 13 +Boerner, Burkhardt+ (TASSO Collab.)
BARNES 82 PL B116 365 +Close (RHEL)
BURKE 81 PL B103 153 +Abrams, Alam, BLocher+ (Mark II Collab.)
BRANDELIK 80B PL B97 448 +Boerner, Burkhard+ (TASSO Collab.)
GUTBROD 79 ZP C1 391 +Kramer, Rumpf (DESY)
JAFFE 77 PR D15 267,281 (MIT)
VOLOSHIN 76 ZETF 23 369 Voloshin, Okun (ITEP)

Searches for Top and Fourth Generation Hadrons

See the sections "Searches for t Quark" and "Searches for b' (4^{th} Generation) Quark" at the end of the QUARKS section.