

$f_0(500)$  or  $\sigma$   
was  $f_0(600)$

$$I^G(J^{PC}) = 0^+(0^{++})$$

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### $f_0(500)$ T-MATRIX POLE $\sqrt{s}$

Note that  $\Gamma \approx 2 \text{Im}(\sqrt{s_{\text{pole}}})$ .

| VALUE (MeV)   | DOCUMENT ID                   | TECN | COMMENT   |
|---|-------------------------------|------|---|
| <b>(400–550)–<math>i</math>(200–350) OUR ESTIMATE</b>                         |                               |      |   |
| ● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ● |                               |      |   |
| $(440 \pm 10) - i(238 \pm 10)$  | <sup>1</sup> ALBALADEJO 12    | RVUE | Compilation   |
| $(445 \pm 25) - i(278^{+22}_{-18})$   | <sup>2,3</sup> GARCIA-MAR..11 | RVUE | Compilation   |
| $(457^{+14}_{-13}) - i(279^{+11}_{-7})$                                       | <sup>2,4</sup> GARCIA-MAR..11 | RVUE | Compilation   |
| $(442^{+5}_{-8}) - i(274^{+6}_{-5})$  | <sup>5</sup> MOUSSALLAM11     | RVUE | Compilation   |
| $(452 \pm 13) - i(259 \pm 16)$  | <sup>6</sup> MENNESSIER 10    | RVUE | Compilation   |
| $(448 \pm 43) - i(266 \pm 43)$  | <sup>7</sup> MENNESSIER 10    | RVUE | Compilation   |
| $(455 \pm 6^{+31}_{-13}) - i(278 \pm 6^{+34}_{-43})$                          | <sup>8</sup> CAPRINI 08       | RVUE | Compilation   |
| $(463 \pm 6^{+31}_{-17}) - i(259 \pm 6^{+33}_{-34})$                          | <sup>9</sup> CAPRINI 08       | RVUE | Compilation   |
| $(552^{+84}_{-106}) - i(232^{+81}_{-72})$                                     | <sup>10</sup> ABLIKIM 07A     | BES2 | $\psi(2S) \rightarrow \pi^+ \pi^- J/\psi$           |
| $(466 \pm 18) - i(223 \pm 28)$  | <sup>11</sup> BONVICINI 07    | CLEO | $D^+ \rightarrow \pi^- \pi^+ \pi^+$                 |
| $(472 \pm 30) - i(271 \pm 30)$  | <sup>12</sup> BUGG 07A        | RVUE | Compilation   |
| $(484 \pm 17) - i(255 \pm 10)$  | GARCIA-MAR..07                | RVUE | Compilation   |
| $(430) - i(325)$  | <sup>13</sup> ANISOVICH 06    | RVUE | Compilation   |
| $(441^{+16}_{-8}) - i(272^{+9}_{-12.5})$                                      | <sup>14</sup> CAPRINI 06      | RVUE | $\pi\pi \rightarrow \pi\pi$                         |
| $(470 \pm 50) - i(285 \pm 25)$  | <sup>15</sup> ZHOU 05         | RVUE |   |
| $(541 \pm 39) - i(252 \pm 42)$  | <sup>16</sup> ABLIKIM 04A     | BES2 | $J/\psi \rightarrow \omega \pi^+ \pi^-$             |
| $(528 \pm 32) - i(207 \pm 23)$  | <sup>17</sup> GALLEGOS 04     | RVUE | Compilation   |
| $(440 \pm 8) - i(212 \pm 15)$   | <sup>18</sup> PELAEZ 04A      | RVUE | $\pi\pi \rightarrow \pi\pi$                         |
| $(533 \pm 25) - i(249 \pm 25)$  | <sup>19</sup> BUGG 03         | RVUE |   |
| $517 - i240$  | BLACK 01                      | RVUE | $\pi^0 \pi^0 \rightarrow \pi^0 \pi^0$               |
| $(470 \pm 30) - i(295 \pm 20)$  | <sup>14</sup> COLANGELO 01    | RVUE | $\pi\pi \rightarrow \pi\pi$                         |
| $(535^{+48}_{-36}) - i(155^{+76}_{-53})$                                      | <sup>20</sup> ISHIDA 01       |      | $\Upsilon(3S) \rightarrow \Upsilon \pi\pi$          |
| $610 \pm 14 - i620 \pm 26$  | <sup>21</sup> SUROVTSEV 01    | RVUE | $\pi\pi \rightarrow \pi\pi, K\bar{K}$               |
| $(540^{+36}_{-29}) - i(193^{+32}_{-40})$                                      | ISHIDA 00B                    |      | $\rho\bar{\rho} \rightarrow \pi^0 \pi^0 \pi^0$      |
| $445 - i235$  | HANNAH 99                     | RVUE | $\pi$ scalar form factor                            |
| $(523 \pm 12) - i(259 \pm 7)$   | KAMINSKI 99                   | RVUE | $\pi\pi \rightarrow \pi\pi, K\bar{K}, \sigma\sigma$ |
| $442 - i 227$   | OLLER 99                      | RVUE | $\pi\pi \rightarrow \pi\pi, K\bar{K}$               |
| $469 - i203$  | OLLER 99B                     | RVUE | $\pi\pi \rightarrow \pi\pi, K\bar{K}$               |
| $445 - i221$  | OLLER 99C                     | RVUE | $\pi\pi \rightarrow \pi\pi, K\bar{K}, \eta\eta$     |
| $(1530^{+90}_{-250}) - i(560 \pm 40)$   | ANISOVICH 98B                 | RVUE | Compilation   |
| $420 - i 212$   | LOCHER 98                     | RVUE | $\pi\pi \rightarrow \pi\pi, K\bar{K}$               |
| $440 - i245$  | <sup>22</sup> DOBADO 97       | RVUE | Compilation   |
| $(602 \pm 26) - i(196 \pm 27)$  | <sup>23</sup> ISHIDA 97       |      | $\pi\pi \rightarrow \pi\pi$                         |

|                                 |                               |      |   |
|---------------------------------|-------------------------------|------|---|
| $(537 \pm 20) - i(250 \pm 17)$  | <sup>24</sup> KAMINSKI 97B    | RVUE | $\pi\pi \rightarrow \pi\pi, K\bar{K}, 4\pi$                 |
| $470 - i250$                    | <sup>25,26</sup> TORNQVIST 96 | RVUE | $\pi\pi \rightarrow \pi\pi, K\bar{K}, K\pi,$<br>$\eta\pi$   |
| $387 - i305$                    | <sup>26,27</sup> JANSSEN 95   | RVUE | $\pi\pi \rightarrow \pi\pi, K\bar{K}$                       |
| $420 - i370$                    | <sup>28</sup> ACHASOV 94      | RVUE | $\pi\pi \rightarrow \pi\pi$                                 |
| $(506 \pm 10) - i(247 \pm 3)$   | KAMINSKI 94                   | RVUE | $\pi\pi \rightarrow \pi\pi, K\bar{K}$                       |
| $370 - i356$                    | <sup>29</sup> ZOU 94B         | RVUE | $\pi\pi \rightarrow \pi\pi, K\bar{K}$                       |
| $408 - i342$                    | <sup>26,29</sup> ZOU 93       | RVUE | $\pi\pi \rightarrow \pi\pi, K\bar{K}$                       |
| $470 - i208$                    | <sup>30</sup> VANBEVEREN 86   | RVUE | $\pi\pi \rightarrow \pi\pi, K\bar{K}, \eta\eta,$<br>$\dots$ |
| $(750 \pm 50) - i(450 \pm 50)$  | <sup>31</sup> ESTABROOKS 79   | RVUE | $\pi\pi \rightarrow \pi\pi, K\bar{K}$                       |
| $(660 \pm 100) - i(320 \pm 70)$ | PROTOPOP... 73                | HBC  | $\pi\pi \rightarrow \pi\pi, K\bar{K}$                       |
| $650 - i370$                    | <sup>32</sup> BASDEVANT 72    | RVUE | $\pi\pi \rightarrow \pi\pi$                                 |

<sup>1</sup> Applying the chiral unitary approach at NLO to the  $K_{e4}$  data of BATLEY 10 and  $\pi N \rightarrow \pi\pi N$  data of HYAMS 73, GRAYER 74, and PROTOPOPESCU 73.

<sup>2</sup> Uses the  $K_{e4}$  data of BATLEY 10C and the  $\pi N \rightarrow \pi\pi N$  data of HYAMS 73, GRAYER 74, and PROTOPOPESCU 73.

<sup>3</sup> Analytic continuation using Roy equations.

<sup>4</sup> Analytic continuation using GKPY equations.

<sup>5</sup> Using Roy equations.

<sup>6</sup> Average of three variants of the analytic K-matrix model. Uses the  $K_{e4}$  data of BATLEY 08A and the  $\pi N \rightarrow \pi\pi N$  data of HYAMS 73 and GRAYER 74.

<sup>7</sup> Average of the analyses of three data sets in the K-matrix model. Uses the data of BATLEY 08A, HYAMS 73, and GRAYER 74, partially of COHEN 80 or ETKIN 82B.

<sup>8</sup> From the  $K_{e4}$  data of BATLEY 08A and  $\pi N \rightarrow \pi\pi N$  data of HYAMS 73.

<sup>9</sup> From the  $K_{e4}$  data of BATLEY 08A and  $\pi N \rightarrow \pi\pi N$  data of PROTOPOPESCU 73, GRAYER 74, and ESTABROOKS 74.

<sup>10</sup> From a mean of three different  $f_0(500)$  parametrizations. Uses 40k events.

<sup>11</sup> From an isobar model using 2.6k events.

<sup>12</sup> Reanalysis of ABLIKIM 04A, PISLAK 01, and HYAMS 73 data.

<sup>13</sup> Using the N/D method.

<sup>14</sup> From the solution of the Roy equation (ROY 71) for the isoscalar S-wave and using a phase-shift analysis of HYAMS 73 and PROTOPOPESCU 73 data.

<sup>15</sup> Reanalysis of the data from PROTOPOPESCU 73, ESTABROOKS 74, GRAYER 74, ROSSELET 77, PISLAK 03, and AKHMETSHIN 04.

<sup>16</sup> From a mean of six different analyses and  $f_0(500)$  parameterizations.

<sup>17</sup> Using data on  $\psi(2S) \rightarrow J/\psi\pi\pi$  from BAI 00E and on  $\Upsilon(nS) \rightarrow \Upsilon(mS)\pi\pi$  from BUTLER 94B and ALEXANDER 98.

<sup>18</sup> Reanalysis of data from PROTOPOPESCU 73, ESTABROOKS 74, GRAYER 74, and COHEN 80 in the unitarized ChPT model.

<sup>19</sup> From a combined analysis of HYAMS 73, AUGUSTIN 89, AITALA 01B, and PISLAK 01.

<sup>20</sup> A similar analysis (KOMADA 01) finds  $(580^{+79}_{-30}) - i(190^{+107}_{-49})$  MeV.

<sup>21</sup> Coupled channel reanalysis of BATON 70, BENSINGER 71, BAILLON 72, HYAMS 73, HYAMS 75, ROSSELET 77, COHEN 80, and ETKIN 82B using the uniformizing variable.

<sup>22</sup> Using the inverse amplitude method and data of ESTABROOKS 73, GRAYER 74, and PROTOPOPESCU 73.

<sup>23</sup> Reanalysis of data from HYAMS 73, GRAYER 74, SRINIVASAN 75, and ROSSELET 77 using the interfering amplitude method.

<sup>24</sup> Average and spread of 4 variants (“up” and “down”) of KAMINSKI 97B 3-channel model.

<sup>25</sup> Uses data from BEIER 72B, OCHS 73, HYAMS 73, GRAYER 74, ROSSELET 77, CASON 83, ASTON 88, and ARMSTRONG 91B. Coupled channel analysis with flavor symmetry and all light two-pseudoscalars systems.

<sup>26</sup> Demonstrates explicitly that  $f_0(500)$  and  $f_0(1370)$  are two different poles.

<sup>27</sup> Analysis of data from FALVARD 88.

- <sup>28</sup> Analysis of data from OCHS 73, ESTABROOKS 75, ROSSELET 77, and MUKHIN 80.  
<sup>29</sup> Analysis of data from OCHS 73, GRAYER 74, and ROSSELET 77.  
<sup>30</sup> Coupled-channel analysis using data from PROTOPOPESCU 73, HYAMS 73, HYAMS 75, GRAYER 74, ESTABROOKS 74, ESTABROOKS 75, FROGGATT 77, COR-DEN 79, BISWAS 81.  
<sup>31</sup> Analysis of data from APEL 73, GRAYER 74, CASON 76, PAWLICKI 77. Includes spread and errors of 4 solutions.  
<sup>32</sup> Analysis of data from BATON 70, BENSINGER 71, COLTON 71, BAILLON 72, PRO-TOPOPESCU 73, and WALKER 67.

## $f_0(500)$ BREIT-WIGNER MASS OR K-MATRIX POLE PARAMETERS

| VALUE (MeV)   | DOCUMENT ID                | TECN     | COMMENT  |
|---|----------------------------|----------|--|
| <b>(400–550) OUR ESTIMATE</b>   |                            |          |  |
| • • • We do not use the following data for averages, fits, limits, etc. • • • |                            |          |  |
| $513 \pm 32$  | <sup>33</sup> MURAMATSU 02 | CLEO     | $e^+ e^- \approx 10 \text{ GeV}$   |
| $478^{+24}_{-23} \pm 17$  | AITALA                     | 01B E791 | $D^+ \rightarrow \pi^- \pi^+ \pi^+$  |
| $563^{+58}_{-29}$   | <sup>34</sup> ISHIDA       | 01       | $\Upsilon(3S) \rightarrow \Upsilon \pi \pi$  |
| 555   | <sup>35</sup> ASNER        | 00 CLE2  | $\tau^- \rightarrow \pi^- \pi^0 \pi^0 \nu_\tau$  |
| $540 \pm 36$  | ISHIDA                     | 00B      | $p \bar{p} \rightarrow \pi^0 \pi^0 \pi^0$  |
| $750 \pm 4$   | ALEKSEEV                   | 99 SPEC  | $1.78 \pi^- p_{\text{polar}} \rightarrow \pi^- \pi^+ n$  |
| $744 \pm 5$   | ALEKSEEV                   | 98 SPEC  | $1.78 \pi^- p_{\text{polar}} \rightarrow \pi^- \pi^+ n$  |
| $759 \pm 5$   | <sup>36</sup> TROYAN       | 98       | $5.2 n p \rightarrow n p \pi^+ \pi^-$  |
| $780 \pm 30$  | ALDE                       | 97 GAM2  | $450 p p \rightarrow p p \pi^0 \pi^0$  |
| $585 \pm 20$  | <sup>37</sup> ISHIDA       | 97       | $\pi \pi \rightarrow \pi \pi$  |
| $761 \pm 12$  | <sup>38</sup> SVEC         | 96 RVUE  | $6\text{--}17 \pi N_{\text{polar}} \rightarrow \pi^+ \pi^- N$  |
| $\sim 860$  | <sup>39,40</sup> TORNQVIST | 96 RVUE  | $\pi \pi \rightarrow \pi \pi, K \bar{K}, K \pi, \eta \pi$  |
| $1165 \pm 50$   | <sup>41,42</sup> ANISOVICH | 95 RVUE  | $\pi^- p \rightarrow \pi^0 \pi^0 n,$<br>$\bar{p} p \rightarrow \pi^0 \pi^0 \pi^0, \pi^0 \pi^0 \eta, \pi^0 \eta \eta$ |
| $\sim 1000$   | <sup>43</sup> ACHASOV      | 94 RVUE  | $\pi \pi \rightarrow \pi \pi$  |
| $414 \pm 20$  | <sup>38</sup> AUGUSTIN     | 89 DM2   |  |

<sup>33</sup> Statistical uncertainty only.

<sup>34</sup> A similar analysis (KOMADA 01) finds  $526^{+48}_{-37}$  MeV.

<sup>35</sup> From the best fit of the Dalitz plot.

<sup>36</sup>  $6\sigma$  effect, no PWA.

<sup>37</sup> Reanalysis of data from HYAMS 73, GRAYER 74, SRINIVASAN 75, and ROSSELET 77 using the interfering amplitude method.

<sup>38</sup> Breit-Wigner fit to S-wave intensity measured in  $\pi N \rightarrow \pi^- \pi^+ N$  on polarized targets. The fit does not include  $f_0(980)$ .

<sup>39</sup> Uses data from ASTON 88, OCHS 73, HYAMS 73, ARMSTRONG 91B, GRAYER 74, CASON 83, ROSSELET 77, and BEIER 72B. Coupled channel analysis with flavor symmetry and all light two-pseudoscalars systems.

<sup>40</sup> Also observed by ASNER 00 in  $\tau^- \rightarrow \pi^- \pi^0 \pi^0 \nu_\tau$  decays.

<sup>41</sup> Uses  $\pi^0 \pi^0$  data from ANISOVICH 94, AMSLER 94D, and ALDE 95B,  $\pi^+ \pi^-$  data from OCHS 73, GRAYER 74 and ROSSELET 77, and  $\eta \eta$  data from ANISOVICH 94.

<sup>42</sup> The pole is on Sheet III. Demonstrates explicitly that  $f_0(500)$  and  $f_0(1370)$  are two different poles.

<sup>43</sup> Analysis of data from OCHS 73, ESTABROOKS 75, ROSSELET 77, and MUKHIN 80.

## $f_0(500)$ BREIT-WIGNER WIDTH

| VALUE (MeV)   | DOCUMENT ID                | TECN     | COMMENT  |
|---|----------------------------|----------|--|
| <b>(400–700) OUR ESTIMATE</b>   |                            |          |  |
| • • • We do not use the following data for averages, fits, limits, etc. • • • |                            |          |  |
| $335 \pm 67$  | <sup>44</sup> MURAMATSU 02 | CLEO     | $e^+ e^- \approx 10 \text{ GeV}$   |
| $324^{+42}_{-40} \pm 21$  | AITALA                     | 01B E791 | $D^+ \rightarrow \pi^- \pi^+ \pi^+$  |
| $372^{+229}_{-95}$  | <sup>45</sup> ISHIDA       | 01       | $\Upsilon(3S) \rightarrow \Upsilon \pi \pi$  |
| 540   | <sup>46</sup> ASNER        | 00 CLE2  | $\tau^- \rightarrow \pi^- \pi^0 \pi^0 \nu_\tau$  |
| $372 \pm 80$  | ISHIDA                     | 00B      | $\rho \bar{p} \rightarrow \pi^0 \pi^0 \pi^0$   |
| $119 \pm 13$  | ALEKSEEV                   | 99 SPEC  | $1.78 \pi^- p_{\text{polar}} \rightarrow \pi^- \pi^+ n$  |
| $77 \pm 22$   | ALEKSEEV                   | 98 SPEC  | $1.78 \pi^- p_{\text{polar}} \rightarrow \pi^- \pi^+ n$  |
| $35 \pm 12$   | <sup>47</sup> TROYAN       | 98       | $5.2 n p \rightarrow n p \pi^+ \pi^-$  |
| $780 \pm 60$  | ALDE                       | 97 GAM2  | $450 p p \rightarrow p p \pi^0 \pi^0$  |
| $385 \pm 70$  | ISHIDA                     | 97       | $\pi \pi \rightarrow \pi \pi$  |
| $290 \pm 54$  | <sup>49</sup> SVEC         | 96 RVUE  | $6\text{--}17 \pi N_{\text{polar}} \rightarrow \pi^+ \pi^- N$  |
| $\sim 880$  | <sup>50,51</sup> TORNQVIST | 96 RVUE  | $\pi \pi \rightarrow \pi \pi, K \bar{K}, K \pi, \eta \pi$  |
| $460 \pm 40$  | <sup>52,53</sup> ANISOVICH | 95 RVUE  | $\pi^- p \rightarrow \pi^0 \pi^0 n,$<br>$\bar{p} p \rightarrow \pi^0 \pi^0 \pi^0, \pi^0 \pi^0 \eta, \pi^0 \eta \eta$ |
| $\sim 3200$   | <sup>54</sup> ACHASOV      | 94 RVUE  | $\pi \pi \rightarrow \pi \pi$  |
| $494 \pm 58$  | <sup>49</sup> AUGUSTIN     | 89 DM2   |  |

<sup>44</sup> Statistical uncertainty only.

<sup>45</sup> A similar analysis (KOMADA 01) finds  $301^{+145}_{-100}$  MeV.

<sup>46</sup> From the best fit of the Dalitz plot.

<sup>47</sup>  $6\sigma$  effect, no PWA.

<sup>48</sup> Reanalysis of data from HYAMS 73, GRAYER 74, SRINIVASAN 75, and ROSSELET 77 using the interfering amplitude method.

<sup>49</sup> Breit-Wigner fit to S-wave intensity measured in  $\pi N \rightarrow \pi^- \pi^+ N$  on polarized targets. The fit does not include  $f_0(980)$ .

<sup>50</sup> Uses data from ASTON 88, OCHS 73, HYAMS 73, ARMSTRONG 91B, GRAYER 74, CASON 83, ROSSELET 77, and BEIER 72B. Coupled channel analysis with flavor symmetry and all light two-pseudoscalars systems.

<sup>51</sup> Also observed by ASNER 00 in  $\tau^- \rightarrow \pi^- \pi^0 \pi^0 \nu_\tau$  decays.

<sup>52</sup> Uses  $\pi^0 \pi^0$  data from ANISOVICH 94, AMSLER 94D, and ALDE 95B,  $\pi^+ \pi^-$  data from OCHS 73, GRAYER 74 and ROSSELET 77, and  $\eta \eta$  data from ANISOVICH 94.

<sup>53</sup> The pole is on Sheet III. Demonstrates explicitly that  $f_0(500)$  and  $f_0(1370)$  are two different poles.

<sup>54</sup> Analysis of data from OCHS 73, ESTABROOKS 75, ROSSELET 77, and MUKHIN 80.

## $f_0(500)$ DECAY MODES

| Mode                       | Fraction ( $\Gamma_i/\Gamma$ ) |
|----------------------------|--------------------------------|
| $\Gamma_1$ $\pi \pi$       | dominant                       |
| $\Gamma_2$ $\gamma \gamma$ | seen                           |

**$f_0(500)$  PARTIAL WIDTHS**

| $\Gamma(\gamma\gamma)$  |                     |      |   | $\Gamma_2$ |
|---|---------------------|------|---|------------|
| VALUE (keV)   | DOCUMENT ID         | TECN | COMMENT   |            |
| • • • We do not use the following data for averages, fits, limits, etc. • • • |                     |      |   |            |
| 1.7 $\pm$ 0.4   | 55 HOFERICHTER11    | RVUE | Compilation                                       |            |
| 3.08 $\pm$ 0.82   | 56 MENNESSIER 11    | RVUE | Compilation                                       |            |
| 2.08 $\pm$ 0.2 <sup>+0.07</sup> <sub>-0.04</sub>                              | 57 MOUSSALLAM11     | RVUE | Compilation                                       |            |
| 2.08  | 58 MAO 09           | RVUE | Compilation                                       |            |
| 1.2 $\pm$ 0.4   | 59 BERNABEU 08      | RVUE |   |            |
| 3.9 $\pm$ 0.6   | 56 MENNESSIER 08    | RVUE | $\gamma\gamma \rightarrow \pi^+\pi^-, \pi^0\pi^0$ |            |
| 1.8 $\pm$ 0.4   | 60 OLLER 08         | RVUE | Compilation                                       |            |
| 1.68 $\pm$ 0.15   | 60,61 OLLER 08A     | RVUE | Compilation                                       |            |
| 3.1 $\pm$ 0.5   | 62,63 PENNINGTON 08 | RVUE | Compilation                                       |            |
| 2.4 $\pm$ 0.4   | 63,64 PENNINGTON 08 | RVUE | Compilation                                       |            |
| 4.1 $\pm$ 0.3   | 65 PENNINGTON 06    | RVUE | $\gamma\gamma \rightarrow \pi^0\pi^0$             |            |
| 3.8 $\pm$ 1.5   | 66,67 BOGLIONE 99   | RVUE | $\gamma\gamma \rightarrow \pi^+\pi^-, \pi^0\pi^0$ |            |
| 5.4 $\pm$ 2.3   | 66 MORGAN 90        | RVUE | $\gamma\gamma \rightarrow \pi^+\pi^-, \pi^0\pi^0$ |            |
| 10 $\pm$ 6  | COURAU 86           | DM1  | $e^+e^- \rightarrow \pi^+\pi^-e^+e^-$             |            |

<sup>55</sup> Using Roy-Steiner equations with  $\pi\pi$  phase shifts from an update of COLANGELO 01 and from GARCIA-MARTIN 11A.

<sup>56</sup> Using an analytic K-matrix model.

<sup>57</sup> Using dispersion integral with phase input from Roy equations and data from MARSISKE 90, BOYER 90, BEHREND 92, UEHARA 08A, and MORI 07.

<sup>58</sup> Used dispersion theory. The value quoted used the  $f_0(500)$  pole position of  $457 - i276$  MeV.

<sup>59</sup> Using  $p$ ,  $n$  polarizabilities from PDG 06 and fitting to  $\pi\pi$  phase motion from GARCIA-MARTIN 07 and  $\sigma$ -poles from GARCIA-MARTIN 07 and CAPRINI 06.

<sup>60</sup> Using twice-subtracted dispersion integrals.

<sup>61</sup> Supersedes OLLER 08.

<sup>62</sup> Solution A (preferred solution based on  $\chi^2$ -analysis).

<sup>63</sup> Dispersion theory based amplitude analysis of BOYER 90, MARSISKE 90, BEHREND 92, and MORI 07.

<sup>64</sup> Solution B (worse than solution A; still acceptable when systematic uncertainties are included).

<sup>65</sup> Using unitarity and the  $\sigma$  pole position from CAPRINI 06.

<sup>66</sup> This width could equally well be assigned to the  $f_0(1370)$ . The authors analyse data from BOYER 90 and MARSISKE 90 and report strong correlation with  $\gamma\gamma$  width of  $f_2(1270)$ .

<sup>67</sup> Supersedes MORGAN 90.

 **$f_0(500)$  REFERENCES**

|                   |                |   |                       |
|-------------------|----------------|---|-----------------------|
| ALBALADEJO 12     | PR D86 034003  | M. Albaladejo, J.A. Oller               | (MURC)                |
| GARCIA-MAR... 11  | PRL 107 072001 | R. Garcia-Martin <i>et al.</i>          | (MADR, CRAC)          |
| GARCIA-MAR... 11A | PR D83 074004  | R. Garcia-Martin <i>et al.</i>          | (MADR, CRAC)          |
| HOFERICHTER 11    | EPJ C71 1743   | M. Hoferichter, D.R. Phillips, C. Schat | (BONN+)               |
| MENNESSIER 11     | PL B696 40     | G. Mennessier, S. Narison, X.-G. Wang   |                       |
| MOUSSALLAM 11     | EPJ C71 1814   | B. Moussallam                           |                       |
| BATLEY 10         | PL B686 101    | J.R. Batley <i>et al.</i>               | (CERN NA48/2 Collab.) |
| BATLEY 10C        | EPJ C70 635    | J.R. Batley <i>et al.</i>               | (CERN NA48/2 Collab.) |
| MENNESSIER 10     | PL B688 59     | G. Mennessier, S. Narison, X.-G. Wang   |                       |
| MAO 09            | PR D79 116008  | Y. Mao <i>et al.</i>                    |                       |
| BATLEY 08A        | EPJ C54 411    | J.R. Batley <i>et al.</i>               | (CERN NA48/2 Collab.) |
| BERNABEU 08       | PRL 100 241804 | J. Bernabeu, J. Prades                  | (IFIC, GRAN)          |

|               |     |                              |  |                             |
|---------------|-----|------------------------------|--|-----------------------------|
| CAPRINI       | 08  | PR D77 114019                | I. Caprini                                   |                             |
| MENNESSIER    | 08  | PL B665 205                  | G. Mennessier, S. Narison, W. Ochs           |                             |
| OLLER         | 08  | PL B659 201                  | J.A. Oller, L. Roca, C. Schat                | (MURC, UBA)                 |
| OLLER         | 08A | EPJ A37 15                   | J.A. Oller, L. Roca                          | (MURC)                      |
| PENNINGTON    | 08  | EPJ C56 1                    | M.R. Pennington <i>et al.</i>                |                             |
| UEHARA        | 08A | PR D78 052004                | S. Uehara <i>et al.</i>                      | (BELLE Collab.)             |
| ABLIKIM       | 07A | PL B645 19                   | M. Ablikim <i>et al.</i>                     | (BES Collab.)               |
| BONVICINI     | 07  | PR D76 012001                | G. Bonvicini <i>et al.</i>                   | (CLEO Collab.)              |
| BUGG          | 07A | JPG 34 151                   | D.V. Bugg <i>et al.</i>                      |                             |
| GARCIA-MAR... | 07  | PR D76 074034                | R. Garcia-Martin, J.R. Pelaez, F.J. Yndurain |                             |
| MORI          | 07  | PR D75 051101                | T. Mori <i>et al.</i>                        | (BELLE Collab.)             |
| ANISOVICH     | 06  | IJMP A21 3615                | V.V. Anisovich                               |                             |
| CAPRINI       | 06  | PRL 96 132001                | I. Caprini, G. Colangelo, H. Leutwyler       | (BCIP+)                     |
| PDG           | 06  | JPG 33 1                     | W.-M. Yao <i>et al.</i>                      | (PDG Collab.)               |
| PENNINGTON    | 06  | PRL 97 011601                | M.R. Pennington                              |                             |
| ZHOU          | 05  | JHEP 0502 043                | Z.Y. Zhou <i>et al.</i>                      |                             |
| ABLIKIM       | 04A | PL B598 149                  | M. Ablikim <i>et al.</i>                     | (BES Collab.)               |
| AKHMETSHIN    | 04  | PL B578 285                  | R.R. Akhmetshin <i>et al.</i>                | (Novosibirsk CMD-2 Collab.) |
| GALLEGOS      | 04  | PR D69 074033                | A. Gallegos <i>et al.</i>                    |                             |
| PELAEZ        | 04A | MPL A19 2879                 | J.R. Pelaez                                  |                             |
| BUGG          | 03  | PL B572 1                    | D.V. Bugg                                    |                             |
| PISLAK        | 03  | PR D67 072004                | S. Pislak <i>et al.</i>                      | (BNL E865 Collab.)          |
| Also          |     | PR D81 119903E               | S. Pislak <i>et al.</i>                      | (BNL E865 Collab.)          |
| MURAMATSU     | 02  | PRL 89 251802                | H. Muramatsu <i>et al.</i>                   | (CLEO Collab.)              |
| Also          |     | PRL 90 059901 (errata)       | H. Muramatsu <i>et al.</i>                   | (CLEO Collab.)              |
| AITALA        | 01B | PRL 86 770                   | E.M. Aitala <i>et al.</i>                    | (FNAL E791 Collab.)         |
| BLACK         | 01  | PR D64 014031                | D. Black <i>et al.</i>                       |                             |
| COLANGELO     | 01  | NP B603 125                  | G. Colangelo, J. Gasser, H. Leutwyler        |                             |
| ISHIDA        | 01  | PL B518 47                   | M. Ishida <i>et al.</i>                      |                             |
| KOMADA        | 01  | PL B508 31                   | T. Komada <i>et al.</i>                      |                             |
| PISLAK        | 01  | PRL 87 221801                | S. Pislak <i>et al.</i>                      | (BNL E865 Collab.)          |
| Also          |     | PR D67 072004                | S. Pislak <i>et al.</i>                      | (BNL E865 Collab.)          |
| Also          |     | PRL 105 019901E              | S. Pislak <i>et al.</i>                      | (BNL E865 Collab.)          |
| SUROVTSEV     | 01  | PR D63 054024                | Y.S. Surovtsev, D. Krupa, M. Nagy            |                             |
| ASNER         | 00  | PR D61 012002                | D.M. Asner <i>et al.</i>                     | (CLEO Collab.)              |
| BAI           | 00E | PR D62 032002                | J. Bai <i>et al.</i>                         | (BES Collab.)               |
| ISHIDA        | 00B | PTP 104 203                  | M. Ishida <i>et al.</i>                      |                             |
| ALEKSEEV      | 99  | NP B541 3                    | I.G. Alekseev <i>et al.</i>                  |                             |
| BOGLIONE      | 99  | EPJ C9 11                    | M. Boglione, M.R. Pennington                 |                             |
| HANNAH        | 99  | PR D60 017502                | T. Hannah                                    |                             |
| KAMINSKI      | 99  | EPJ C9 141                   | R. Kaminski, L. Lesniak, B. Loiseau          | (CRAC, PARIN)               |
| OLLER         | 99  | PR D60 099906 (erratum)      | J.A. Oller <i>et al.</i>                     |                             |
| OLLER         | 99B | NP A652 407 (erratum)        | J.A. Oller, E. Oset                          |                             |
| OLLER         | 99C | PR D60 074023                | J.A. Oller, E. Oset                          |                             |
| ALEKSEEV      | 98  | PAN 61 174                   | I.G. Alekseev <i>et al.</i>                  |                             |
| ALEXANDER     | 98  | PR D58 052004                | J.P. Alexander <i>et al.</i>                 | (CLEO Collab.)              |
| ANISOVICH     | 98B | SPU 41 419                   | V.V. Anisovich <i>et al.</i>                 |                             |
|               |     | Translated from UFN 168 481. |  |                             |
| LOCHER        | 98  | EPJ C4 317                   | M.P. Locher <i>et al.</i>                    | (PSI)                       |
| TROYAN        | 98  | JINRRC 5-91 33               | Yu. Troyan <i>et al.</i>                     |                             |
| ALDE          | 97  | PL B397 350                  | D.M. Alde <i>et al.</i>                      | (GAMS Collab.)              |
| DOBADO        | 97  | PR D56 3057                  | A. Dobado, J.R. Pelaez                       |                             |
| ISHIDA        | 97  | PTP 98 1005                  | S. Ishida <i>et al.</i>                      | (TOKY, MIYA, KEK)           |
| KAMINSKI      | 97B | PL B413 130                  | R. Kaminski, L. Lesniak, B. Loiseau          | (CRAC, IPN)                 |
| Also          |     | PTP 95 745                   | S. Ishida <i>et al.</i>                      | (TOKY, MIYA, KEK)           |
| SVEC          | 96  | PR D53 2343                  | M. Svec                                      | (MCGI)                      |
| TORNQVIST     | 96  | PRL 76 1575                  | N.A. Tornqvist, M. Roos                      | (HELS)                      |
| ALDE          | 95B | ZPHY C66 375                 | D.M. Alde <i>et al.</i>                      | (GAMS Collab.)              |
| ANISOVICH     | 95  | PL B355 363                  | V.V. Anisovich <i>et al.</i>                 | (PNPI, SERP)                |
| JANSSSEN      | 95  | PR D52 2690                  | G. Janssen <i>et al.</i>                     | (STON, ADLD, JULI)          |
| ACHASOV       | 94  | PR D49 5779                  | N.N. Achasov, G.N. Shestakov                 | (NOVM)                      |
| AMSLER        | 94D | PL B333 277                  | C. Amsler <i>et al.</i>                      | (Crystal Barrel Collab.)    |
| ANISOVICH     | 94  | PL B323 233                  | V.V. Anisovich <i>et al.</i>                 | (Crystal Barrel Collab.)    |
| BUTLER        | 94B | PR D49 40                    | F. Butler <i>et al.</i>                      | (CLEO Collab.)              |
| KAMINSKI      | 94  | PR D50 3145                  | R. Kaminski, L. Lesniak, J.P. Maillet        | (CRAC+)                     |
| ZOU           | 94B | PR D50 591                   | B.S. Zou, D.V. Bugg                          | (LOQM)                      |
| ZOU           | 93  | PR D48 R3948                 | B.S. Zou, D.V. Bugg                          | (LOQM)                      |
| BEHREND       | 92  | ZPHY C56 381                 | H.J. Behrend                                 | (CELLO Collab.)             |
| ARMSTRONG     | 91B | ZPHY C52 389                 | T.A. Armstrong <i>et al.</i>                 | (ATHU, BARI, BIRM+)         |
| BOYER         | 90  | PR D42 1350                  | J. Boyer <i>et al.</i>                       | (Mark II Collab.)           |
| MARSISKE      | 90  | PR D41 3324                  | H. Marsiske <i>et al.</i>                    | (Crystal Ball Collab.)      |

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|-------------|-----|--------------|--|--------------------------|
| MORGAN      | 90  | ZPHY C48 623 | D. Morgan, M.R. Pennington                   | (RAL, DURH)              |
| AUGUSTIN    | 89  | NP B320 1    | J.E. Augustin, G. Cosme                      | (DM2 Collab.)            |
| ASTON       | 88  | NP B296 493  | D. Aston <i>et al.</i>                       | (SLAC, NAGO, CINC, INUS) |
| FALVARD     | 88  | PR D38 2706  | A. Falvard <i>et al.</i>                     | (CLER, FRAS, LALO+)      |
| COURAU      | 86  | NP B271 1    | A. Courau <i>et al.</i>                      | (CLER, LALO)             |
| VANBEVEREN  | 86  | ZPHY C30 615 | E. van Beveren <i>et al.</i>                 | (NIJM, BIEL)             |
| CASON       | 83  | PR D28 1586  | N.M. Cason <i>et al.</i>                     | (NDAM, ANL)              |
| ETKIN       | 82B | PR D25 1786  | A. Etkin <i>et al.</i>                       | (BNL, CUNY, TUFTS, VAND) |
| BISWAS      | 81  | PRL 47 1378  | N.N. Biswas <i>et al.</i>                    | (NDAM, ANL)              |
| COHEN       | 80  | PR D22 2595  | D. Cohen <i>et al.</i>                       | (ANL) IJP                |
| MUKHIN      | 80  | JETPL 32 601 | K.N. Mukhin <i>et al.</i>                    | (KIAE)                   |
| CORDEN      | 79  | NP B157 250  | M.J. Corden <i>et al.</i>                    | (BIRM, RHEL, TELA+) JP   |
| ESTABROOKS  | 79  | PR D19 2678  | P. Estabrooks                                | (CARL)                   |
| FROGGATT    | 77  | NP B129 89   | C.D. Froggatt, J.L. Petersen                 | (GLAS, NORD)             |
| PAWLICKI    | 77  | PR D15 3196  | A.J. Pawlicki <i>et al.</i>                  | (ANL) IJ                 |
| ROSSELET    | 77  | PR D15 574   | L. Rosselet <i>et al.</i>                    | (GEVA, SACL)             |
| CASON       | 76  | PRL 36 1485  | N.M. Cason <i>et al.</i>                     | (NDAM, ANL) IJ           |
| ESTABROOKS  | 75  | NP B95 322   | P.G. Estabrooks, A.D. Martin                 | (DURH)                   |
| HYAMS       | 75  | NP B100 205  | B.D. Hyams <i>et al.</i>                     | (CERN, MPIM)             |
| SRINIVASAN  | 75  | PR D12 681   | V. Srinivasan <i>et al.</i>                  | (NDAM, ANL)              |
| ESTABROOKS  | 74  | NP B79 301   | P.G. Estabrooks, A.D. Martin                 | (DURH)                   |
| GRAYR       | 74  | NP B75 189   | G. Grayer <i>et al.</i>                      | (CERN, MPIM)             |
| APEL        | 73  | PL 41B 542   | W.D. Apel <i>et al.</i>                      | (KARL, PISA)             |
| ESTABROOKS  | 73  | Tallahassee  | P.G. Estabrooks <i>et al.</i>                | (CERN, MPIM)             |
| HYAMS       | 73  | NP B64 134   | B.D. Hyams <i>et al.</i>                     | (CERN, MPIM)             |
| OCHS        | 73  | Thesis       | W. Ochs                                      | (MPIM, MUNI)             |
| PROTOPOP... | 73  | PR D7 1279   | S.D. Protopopescu <i>et al.</i>              | (LBL)                    |
| BAILLON     | 72  | PL 38B 555   | P.H. Baillon <i>et al.</i>                   | (SLAC)                   |
| BASDEVANT   | 72  | PL 41B 178   | J.L. Basdevant, C.D. Froggatt, J.L. Petersen | (CERN)                   |
| BEIER       | 72B | PRL 29 511   | E.W. Beier <i>et al.</i>                     | (PENN)                   |
| BENSINGER   | 71  | PL 36B 134   | J.R. Bensinger <i>et al.</i>                 | (WISC)                   |
| COLTON      | 71  | PR D3 2028   | E.P. Colton <i>et al.</i>                    | (LBL, FNAL, UCLA+)       |
| ROY         | 71  | PL 36B 353   | S.M. Roy                                     |                          |
| BATON       | 70  | PL 33B 528   | J.P. Baton, G. Laurens, J. Reignier          | (SACL)                   |
| WALKER      | 67  | RMP 39 695   | W.D. Walker                                  | (WISC)                   |