

Unstable Mesons

Simon Eidelman

Budker Institute of Nuclear Physics,
Novosibirsk, Russia

Outline

1. Team/responsibilities
2. Activities for RPP2008
3. $c\bar{c}$ fit
4. Problems
5. Conclusions

Meson Team

Person	Affiliation	Responsibilities
Claude Amstler	Zurich	Notes
Michael Doser	CERN	Management, notes
Simon Eidelman	Novosibirsk	Literature, notes
Thomas Gutsche	Tübingen	Theory, notes
Juan-Jose Hernández-Rey	Valencia	Notes
Hanna Mahlke-Krüger	Cornell	Notes
Sergio Navas	Granada	<i>cē</i> fit, notes
Claudia Patrignani	Genova	<i>cē</i> fit, notes
Alberto Masoni	Cagliari	Notes
Nils Törnqvist	Helsinki	Theory, notes

Responsibilities

- We are all “encoders” and “overseers” for unstable mesons (LBL terminology)
- In addition, everybody takes care of specific J^{PC} (vectors, scalars, heavy quark states)
- We are also authors and reviewers of our minireviews with the exception of S. Spanier for scalars
- Regular meetings twice a year (October-November, February-March)

Notes

- Papers selected (literature search every 2 months) are assigned to a first reader who writes a note specifying what and how should go to the database
- The first reader sends the note to a randomly selected second reader who adds his/her criticism and comments. Iterations start until both readers agree
- The note approved by both readers is sent to Piotr to be entered in the database
- The first reader checks the input
- In special cases, the whole group discusses the subject

There are three types of papers:

- There are data to quote – usual note written
- No data to quote - brief note to keep trace of the paper. Goes to the database as “Other related papers”. May be used for a minireview
- “Useless” (selected by mistake) – declared empty

Activities for RPP08

- 302 papers selected (**170 in 2004**)
- 794 (**449**) new measurements:
 1. 261 (**258**) – unflavored mesons
 2. 19 (**37**) – other mesons
 3. 27 (**23**) – strange mesons
 4. 39 (**40**) – charmed mesons
 5. 396 (**82**) – $c\bar{c}$ mesons
 6. 52 (**9**) – $b\bar{b}$ mesons
- New interesting particles:
 $\rho(1570)$, $\phi(2170)$, $X(3940)$, $X(4160)$, $X(4360)$, $X(4430)$, $X(4660)$
- 7 minireviews (1 new, 5 updated) + 3 old hidden

c̄c̄ Fit – I

- Experiments measure a product (or a ratio) of the branching ratios, often involving more than one particle
- Values quoted by experiments are often based on RPP averages rather than direct measurements ⇒ **Hidden non-trivial correlations**
- RPP02 introduced a new fit using directly measured quantities ⇒ **cross particle fit, non-standard procedure, standalone fit**
- When a branching ratio is measured in different products/ratios, it is necessary to include it as a new fit parameter
- New measurements of branching ratios by different techniques can result in reentering old measurements in the database:
 1. In 2002 $\mathcal{B}(\chi_{c0} \rightarrow \pi\pi)$ was rescaled from $\mathcal{B}(\psi(2S) \rightarrow \gamma\chi_{c0})\mathcal{B}(\chi_{c0} \rightarrow \pi\pi)$
 2. In 2003 a new measurement of $\mathcal{B}(\chi_{c0} \rightarrow \pi\pi)\mathcal{B}(\chi_{c0} \rightarrow p\bar{p}) \Rightarrow$ the old and new measurements were included in the fit, with a new parameter
 3. The old entries related to $\mathcal{B}(\chi_{c0} \rightarrow \pi\pi)$ measurements had to be recoded

$c\bar{c}$ Fit – II

- To avoid errors two independent fitting codes based on MINUIT perform a cross-check of all results (central values, correlations)
- Fit output is sent to LBL to be entered in the database
- As a non-standard procedure, it is done by hand \Rightarrow considerable additional workload
- A special minireview is describing a new fit providing all details (a correlation matrix) and should be updated for each edition
- Today it covers $\psi(2S)$ and $\chi_{cJ}(1P)$. In 2008 the fit includes 4 total widths, 1 partial width, 24 combinations of partial widths, 8 branching ratios, 66 combinations of \mathcal{B} (44 involve more than one particle), 190 measurements
- A necessity to include new particles can soon appear (e.g., J/ψ and η_c)

Problems

- No data entered directly
- Proofreading incomplete (no ideograms)
- Some features of the relational database missing
- No cross particle fitting
- Limited automatic rescaling
- Should current structure of the entries be expanded to take into account new “properties”?
- According to an old rule, if a particle is observed in a single measurement, it is NOT considered as a new one deserving a separate listing (e.g., new states from Belle and BaBar)

Conclusions

- **Still very active and expanding field**
- Enormous luminosity of B-factories gives access to hadronic systems with different quantum numbers:
 - radiative return – $J^{PC} = 1^{--}$ (from $\rho(770)$ to $X(4660)$)
 - 2γ production – $J^{PC} = 0^{--}, 0^{-+}, 2^{++}, \dots$ (from $f_0(980)$ to $\chi_{c2}(2P)$ (3930))
 - double charmonium production ($\eta_c(2S)$, $X(3940)$, $X(4160)$)
 - B decays – $X(4330)$
- BaBar and Belle collected large $\int L dt$ at $\Upsilon(1, 2, 3, 5S)$
- CLEO-c and BESII -a huge flow of results on regular $c\bar{c}$ states
- VEPP-2M still provides results on the ρ , ω , ϕ ,
- VEPP-2000 starts in 2009, KLOE continues analysis, DAFNE-II discussed
- BES-III just started
- In the more distant future – GSI
- **Physics of unstable mesons is still alive!**