

# Angular Analysis

4<sup>th</sup> Physics of B-Factories workshop  
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# Place in the book

## A.The Facilities

### B.Tools and Methods

- 4 Vertexing
- 5 Multivariate discriminants
  - 5.1 Analysis Optimization
  - 5.2 Particle Identification
  - 5.3 Flavor Tagging
  - 5.4 Background discrimination
- 6 B-meson reconstruction
- 7 Mixing and time dependent analyses
- 8 Maximum-Likelihood fitting
- 9 Angular Analyses
- 10 Dalitz Analysis
- 11 Blind Analysis
- 12 Systematic error estimation

## C.The Results and their Interpretation

- Angular analysis section belongs to Tools and Methods.
- No physics results.
- Discuss tools and underlying physics.

# Status

- **Outline** produced at **Mainz workshop** (October 2010).
- First (preliminary) **draft** released at the beginning of **March 2011**.
  - Phone meeting with editors in March 2011.
- Goal was to have a second draft for Annecy workshop.
  - delayed: should be available in the summer.

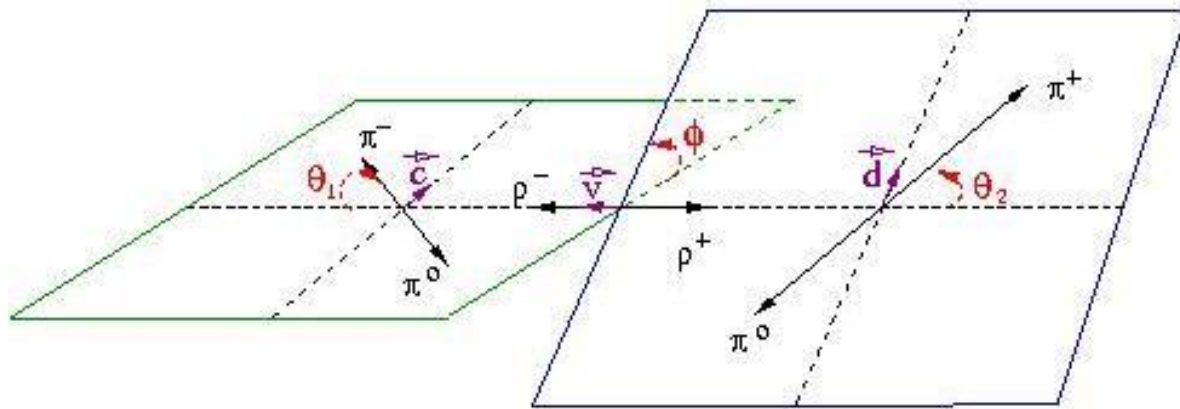
# Current draft

- Short general introduction:
  - What is an angular analysis?
  - What is it used for?
  - Plan of the chapter
- Three main sections:
- 1 Formalism.
- 2 Experimental effects.
- 3 Angular fits.

# Section 1.1: Angular bases

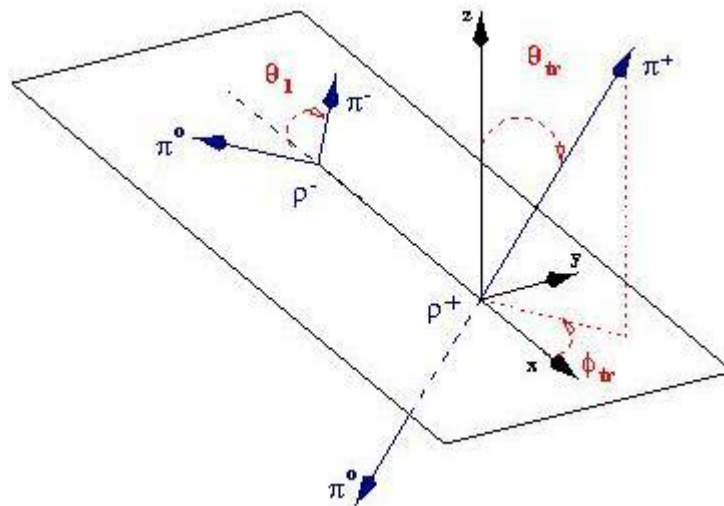
- Decay considered.
  - Focuses on  $B \rightarrow P_1 P_2$ , with spins  $S_1, S_2 \geq 1$  and  $S_1$  or  $S_2 = 1$ .
  - Other cases to introduce.
- Definition of amplitudes.
  - $A_0, A_{+1}, A_{-1}, A_{//}, A_{-|-}$ .
  - Corresponding fractions and phases.
  - Helicity and transversity bases.

# Section 1.2: Angular distributions in Helicity basis



- Angle definition (plot).
- Differential decay rate (general formula).
- One example (  $B \rightarrow K^* \phi$  ).

# Section 1.3: Angular distributions in Transversity basis



- Angle definition (plot).
- Differential decay rate (general formula).
- One example (  $B \rightarrow K^* J/\psi$  ).

## Section 1.4: CP violation

- Define additional CP parameters.

## Section 1.5: Time dependence

- Time dependent formula.



# Section 2: Experimental effects

- Efficiency dependence.
  - Efficiency variation  $\varepsilon(\cos \theta)$ .
  - Cut on  $\cos \theta$ .
- Correlation of variables.
  - e.g. mass-helicity angle correlation in the continuum background.

# Section 3: Angular fits

- Strategy:
  - After signal extraction, final dedicated fit.
  - Global maximum likelihood fit.
- Angular information:
  - Partial angular analysis.
  - Full angular analysis.

# Work in progress

- Add a new section:
  - To review and categorize the different channels, relevant for angular analyses.
  - Depend on daughters and also on grand daughters.
  - Put as section 2 (between formalism and experimental effects).
  - Giving, at least for all the common channels, the base usually used.
  - Giving the corresponding formula for the differential decay rate.
- “Catalogue of modes”.

# Possible division

$$\frac{1}{\Gamma} \frac{d^3\Gamma}{d\cos\theta_1 d\cos\theta_2 d\phi} = \frac{9}{8\pi} \sum \alpha_i f_i(\cos\theta_1, \cos\theta_2, \phi)$$

- In the formalism section.

$$f_1 = \cos^2 \theta_1 \cos^2 \theta_2$$

$$f_2 = \frac{1}{4} \sin^2 \theta_1 \sin^2 \theta_2$$

$$f_3 = \frac{1}{4} \sin^2 \theta_1 \sin^2 \theta_2 \cos 2\phi$$

$$f_4 = -\frac{1}{2} \sin^2 \theta_1 \sin^2 \theta_2 \sin 2\phi$$

$$f_5 = \frac{1}{2\sqrt{2}} \sin 2\theta_1 \sin 2\theta_2 \cos \phi$$

$$f_6 = -\frac{1}{2\sqrt{2}} \sin 2\theta_1 \sin 2\theta_2 \sin \phi$$

- In the catalogue section (example of  $B \rightarrow VV$  with  $V \rightarrow PP$ ).

# References to physics papers

- Put a reference to all Babar and Belle papers involving an angular analysis.
  - Is this what we want?
  - Catalogue section would be to natural place to do that.

# Conclusion

- Work on angular analysis section is still ongoing.
  - First (incomplete) draft available.
  - Working towards a more complete version.