Measurements of the B^{**} and B_s^{**} Mass Peaks and B Mixing using Data from the OPAL Experiment

Andrew Nigel Bell

Thesis submitted for the degree of Doctor of Philosophy

October 1997

School of Physics and Space Research
Faculty of Science
The University of Birmingham

Synopsis

The OPAL detector has been used to collect data from decays of the Z^0 boson, produced with e^+e^- collisions at the LEP collider. Events recorded between 1991 and 1995 were used in measurements of time averaged B mixing and to study the properties of the B^{**} and B_s^{**} mass peaks.

The time averaged B mixing parameter χ was measured using data collected from 1992 to 1994. The method involved the measurement of jet charge in one hemisphere and lepton charge in the opposite hemisphere to identify the charge of the b quark at production and decay. The value measured is:

$$\chi = 0.100 \pm 0.012(\mathrm{stat}) \pm 0.020(\mathrm{syst})$$

The properties of the B^{**} and B_s^{**} mass peaks have been studied using the full data set. B hadrons were reconstructed using a vertex weight method and then combined with pions(B^{**}) or kaons(B_s^{**}) coming from the primary vertex. Monte Carlo data was used extensively in the optimisation of the B reconstruction and initial studies of the background. The background was finally estimated using the data sample itself.

The Q distribution of the B^{**} signal was fitted to a combination of two narrow and one wide Breit Wigner convoluted with the experimental resolution. The following parameters were then measured from a fit to this distribution.

$$\begin{aligned}
Q(1) &= 0.277 \pm 0.007(\mathrm{stat})^{+0.008}_{-0.023}(\mathrm{syst}) \\
Q(2) &= 0.367 \pm 0.018(\mathrm{stat})^{+0.015}_{-0.068}(\mathrm{syst}) \\
\frac{\sigma_{B^{**}}}{\sigma_{b-jet}} &= 0.294 \pm 0.018(\mathrm{data\ stat}) \pm 0.0015(\mathrm{mc\ stat})^{+0.024}_{-0.023}(\mathrm{syst})
\end{aligned}$$

The B_s^{**} signal was also fitted to a combination of two narrow and one wide Breit Wigner convoluted with the experimental resolution and the following parameters were then measured

$$
\begin{aligned}
Q(1) &= 0.0363 \pm 0.0028(\mathrm{stat})^{+0.0003}_{-0.0055}(\mathrm{syst}) \\
Q(2) &= 0.117 \pm 0.012(\mathrm{stat})^{+0.007}_{-0.020}(\mathrm{syst}) \\
\frac{\sigma_{\mathrm{B}_s^{**}}}{\sigma_{b-jet}} &= 0.0576 \pm 0.0036(\mathrm{data\ stat}) \pm 0.0011(\mathrm{mc\ stat})^{+0.0059}_{-0.0061}(\mathrm{syst})
\end{aligned}
$$

These results have been compared with similar measurements from other experiments.