Measurement of $D^0$ decays into $K^0\omega$, $K^0\eta$ and $K^{*0}\eta$

ARGUS Collaboration

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Abstract. Using the ARGUS detector at the electron-positron storage ring DORIS II at DESY, we have measured the branching ratios of the D^0 meson decays into \( K^0 \omega \), \( K^0 \eta \) and \( K^{*0} \eta \) relative to the \( K^- \pi^+ \) mode. Using the known branching ratio \( Br(D^0 \rightarrow K^- \pi^+) = (4.2 \pm 0.4 \pm 0.4\%) \) we find \( Br(D^0 \rightarrow K^0 \omega) = (4.2 \pm 1.6 \pm 0.9\%) \), \( Br(D^0 \rightarrow K^0 \eta) < 2.7\% \) (90\% CL) and \( Br(D^0 \rightarrow K^{*0} \eta) < 2.9\% \) (90\% CL).

The observation of the \( D^0 \) decay mode \( \bar{K}^0 \phi \) with a branching ratio of about 1\% by ARGUS [1], MARK III [2] and CLEO [3] was originally considered as evidence for the existence of non-spectator processes by Bigi and Fukugita [4]. More recently however, in some models rescattering effects produce this \( D^0 \) decay even in the absence of weak annihilation [5–7]. The \( D^0 \) decay modes \( K^0 \omega \), \( K^0 \eta \) and \( K^{*0} \eta \) should also be sensitive to final state interactions in these models. Table 1 lists predictions of various models including the QCD sum rule predictions of Blok and Shifman [8], which do not contain final state interactions. Measurements of the \( D^0 \) decays into \( \bar{K}^0 \omega \), \( \bar{K}^0 \eta \) and \( \bar{K}^{*0} \eta \) are therefore of theoretical interest.

The data sample used for our study corresponds to an integrated luminosity of 189\( /pb \), obtained with the ARGUS detector on the \( \Upsilon(2S) \) and \( \Upsilon(4S) \) resonances and in the nearby continuum. A short description of the ARGUS detector, its trigger conditions and the method of charged particle identification can be found in previous publications [9]. The \( D^0 \) decay into \( K^- \pi^+ \) was used to normalize the other decays; the mass distribution of these candidates is shown in Fig. 1a. Since the fragmentation of charmed quarks produces a hard \( D^0 \) momentum spectrum we required the scaled momentum \( x_p = p(K^- \pi^+)/p_{\text{max}}(D^0) \) to be greater than 0.55 for all measured \( D^0 \) decays. This cut reduces the combinatorial background considerably as shown in Fig. 1b. From a fit with a gaussian and a second-order polynomial background we find the signal at a mass of \( (1863.8 \pm 1.3) \text{ MeV}/c^2 \) with a width, consistent with expectation, of \( \sigma = (31.4 \pm 1.6) \text{ MeV} \). We observed \( 3323 \pm 170 \) \( D^0 \) mesons in this decay mode.

The \( K^0 \) mesons from the \( D^0 \) decays into \( \bar{K}^0 \omega \) and into \( \bar{K}^0 \eta \) are reconstructed in the \( K^0 \) decay mode \( \pi^+ \pi^- \). A cut on the angle \( \delta \) between the momentum vector of the \( (\pi^+ \pi^-) \)-system and the direction from the interaction point to the decay vertex, \( \cos \delta > 0.9 \), provides us with an almost background free \( K^0 \) sample. The \( \omega \) meson is reconstructed through its \( \pi^+ \pi^- \pi^0 \) mode, the \( \eta \) meson in the same mode and through the decay into \( \gamma \gamma \). Based on the number of shower counters set by an incoming particle, the amount of energy deposited in the shower counters, and the lateral distribution of the energy, a cut was used to reduce the background from hadronic showers in the photon identification [10]. The energy of the photons was required to be greater than 40 MeV. To improve the resolution on the \( \omega \) and \( \eta \) mass in

<table>
<thead>
<tr>
<th>( K^0 \omega )</th>
<th>( K^0 \eta )</th>
<th>( K^{*0} \eta )</th>
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<tbody>
<tr>
<td>Bauer, Stech and Wirbel [5]</td>
<td>3.0%</td>
<td>0.4%</td>
</tr>
<tr>
<td>Donoghue [6]</td>
<td>&gt;2%</td>
<td></td>
</tr>
<tr>
<td>Kamal [7]</td>
<td>1.5%</td>
<td>0.4%</td>
</tr>
<tr>
<td>Blok and Shifman [8]</td>
<td>1.5%</td>
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Table 1. Branching ratio predictions for the studied decay modes