SPECTROSCOPY WITH ARGUS

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The following results were obtained from data taken with the ARGUS detector at the e^+e^- storage ring DORIS II. The data sample comprises 510000 multihadronic events including 140000 $\Upsilon(2S)$ decays, 70000 $\Upsilon(1S)$ decays, 8000 $\Upsilon(4S)$ decays and 290000 events coming mainly from the continuum below the resonances. The ARGUS detector has unique features in detecting and identifying hadrons, leptons and photons over a large solid angle [1]. $\pi^\pm$, $K^\pm$ and p ($\bar{p}$) can be identified unambigously in more than 80% of all cases.

1. Radiative decays of the $\Upsilon(2S)$

In order to get an excellent energy resolution for photons at low energies the ARGUS detector was used as a pair-spectrometer : the photons converting in front of the ARGUS driftchamber into an e^+e^- pair were measured by detecting both leptons which have to come from a secondary vertex. The calibration was checked carefully by reconstructing π^0 decaying into two converted photons. The resulting photon spectrum from $\Upsilon(2S)$ decays exhibits 3 photon lines which are attributed to transition $\Upsilon(2S) \to \gamma^3P_J$, J=2,1,0. The photon energies E_γ and branchung ratios BR are shown in table 1 where the resolutions σ_E and efficiencies η are results of detailed Monte Carlo calculations.

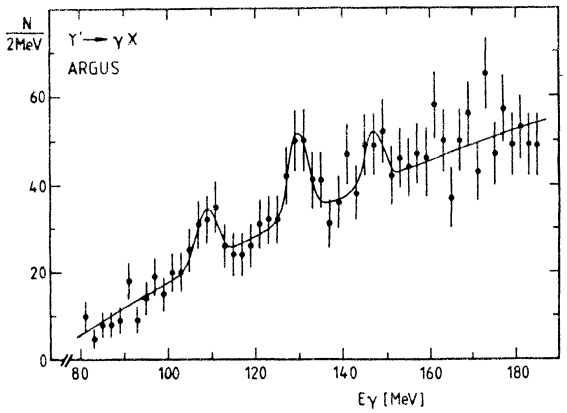

Fig.1 Inclusive photon spectrum from radiative $\Upsilon(2S)$ decays.

Table 1

E_γ(MeV)	BR(%)	σ_E(MeV)	η(%)
109.0±1.0±1.0	8.9±3.0±1.2	2.3	2.3
129.8±0.8±1.0	8.8±2.2±1.0	2.1	3.7
147.2±1.4±1.0	4.0±1.8±1.0	2.0	5.1

2. The transition $\Upsilon(2S) \to \pi^+\pi^-\Upsilon(1S)$

The transition $\Upsilon(2S) \to \pi^+\pi^-\Upsilon(1S)$ was measured with high statistics. From more than 8000 transitions the invariant $\pi^+\pi^-$-mass spectrum was determined. Fig.2 shows a comparison between the J/Ψ- and the Υ- system. A significant difference between both distributions is observed which can be expressed in a decrease of the κ- value, when going from the J/Ψ- to the Υ- system [3]:
$\kappa(J/\Psi) = 0.194 \pm 0.010$, $\kappa(\Upsilon) = 0.145 \pm 0.015$.
The emission and decay angular distributions for the $\pi^+\pi^-$-system is shown in fig.3. All distributions are compatible with an isotropic emission and decay of the $\pi^+\pi^-$-system (solid lines).

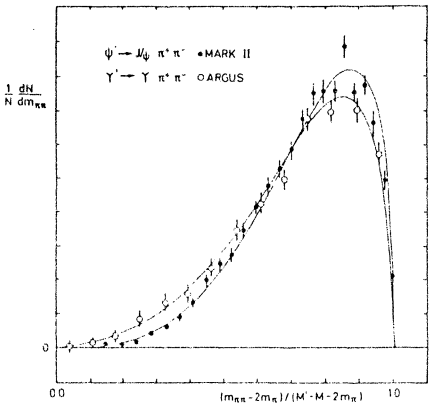

Fig.2 Invariant $\pi^+\pi^-$-mass spectrum for the transitions $\Upsilon(2S) \to \pi^+\pi^-\Upsilon(1S)$ and $\Psi \to \pi^+\pi^-J/\Psi$ [2]

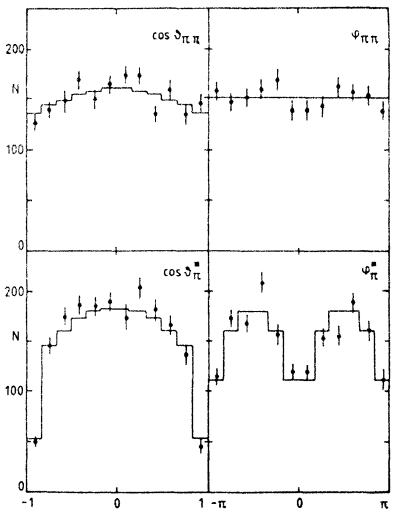

Fig.3 Emission and decay angular distribution for the transition $\Upsilon(2S) \to \pi^+\pi^-\Upsilon(1S)$

3. D^*- and D^0 - production

Charged D^*-mesons were identified by the well established procedure [4] using the $D^{*+} \to D^0\pi^+$ decay. 191±19 such decays with $D^0 \to K^-\pi^+$ and 216±21 decays with $D^0 \to K^-\pi^+\pi^+\pi^-$ were observed. The resulting mass difference and invariant mass plots are shown in fig.4 and 5.

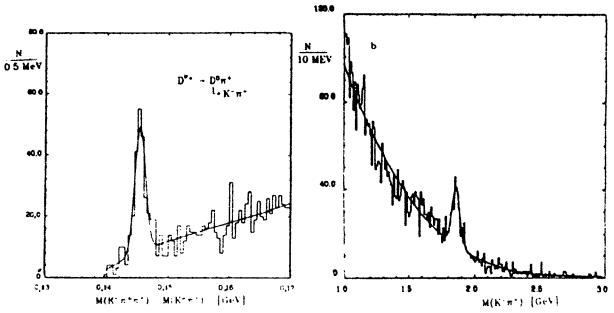

Fig.4 $D^{*+} \to D^0\pi^+$, $D^0 \to K^-\pi^+$ decay.
a. ΔM for $1.825 < M(K^-\pi^+) < 1.905$ GeV
b. $M(K^-\pi^+)$ for $143 < \Delta M < 148$ MeV

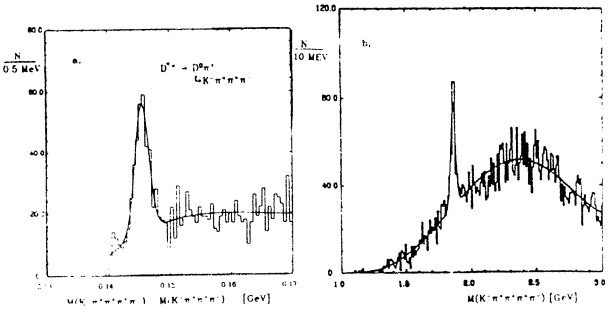

Fig.5 $D^{*+} \to D^0\pi^+$, $D^0 \to K^-\pi^+\pi^+\pi^-$ decay.
a. ΔM for $1.835 < M(K^-\pi^+\pi^+\pi^-) < 1.895$ GeV
b. $M(K^-\pi^+\pi^+\pi^-)$ for $143 < \Delta M < 148$ MeV

The mass difference $\Delta M = M(D^{*+}) - M(D^0)$ was determined to be $\Delta M = (145.46 \pm 0.07 \pm 0.03)$ MeV. The ratio of branching ratios for the observed D^0-decays is given by

$$\frac{Br(D^0 \to K^-\pi^+\pi^+\pi^-)}{Br(D^0 \to K^-\pi^+)} = 2.17 \pm 0.28 \pm 0.23$$

4. $D^0 - \bar{D}^0$ - mixing

$D^0 - \bar{D}^0$ - mixing was investigated by comparing the mass difference plots $M(K^-\pi^+\pi^-) - M(K^-\pi^+)$ and $M(K^+\pi^-\pi^+) - M(K^+\pi^-)$. From 30 correct sign combinations and 2 wrong sign combinations an upper limit of 11 % at 90 % C.L. for $D^0 - \bar{D}^0$ - mixing was determined.

5. F^*- and F - production.

F- mesons have been detected by their decay $F \to \Phi\pi$ with 80±16 events and $F \to \Phi 3\pi$ with 65±16 events, the Φ decaying into K^+K^- (Fig. 6)
The results on masses and branching ratios are listed in table 2.

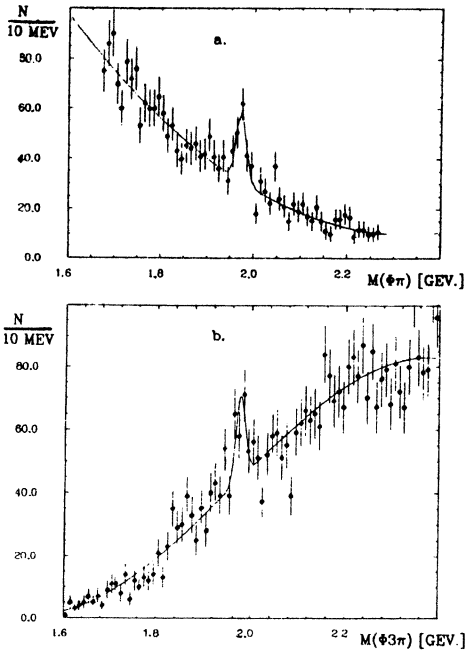

Fig. 6 a. $M(\Phi\pi)$, $P(\Phi\pi) > 1.5$ GeV
b. $M(\Phi 3\pi)$, $P(\Phi 3\pi) > 2.2$ GeV

Table 2

Decay	Mass (GeV)	R * B(%)
$F \to \Phi\pi$	$1.963 \pm 0.003 \pm 0.003$	$3.3 \pm 1.1 \pm 1.2$
$F \to \Phi 3\pi$	$1.967 \pm 0.003 \pm 0.003$	$1.7 \pm 0.5 \pm 0.5$

$$R = \sigma(e^+e^- \to F + X) / \sigma_{\mu\mu}$$

By adding a photon measured in the ARGUS - calorimeter to the F, where $F \to \Phi\pi$, a signal is seen in the $F\gamma$-mass distribution which is interpreted as the observation of the F^*- meson. The resulting mass is $M(F^*) = 2.109 \pm 0.009 \pm 0.007$ GeV. From the number of observed F - and F^*- mesons it is concluded that more than 66% of all F's are coming from F^*'s at 84 % C.L..

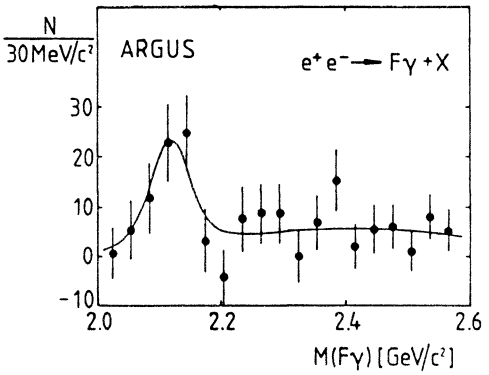

Fig. 7 $M(F\gamma)$, $P(F) > 1.65$ GeV

1. H. Albrecht et al., Phys.Lett.134B(1984)137
2. G.S. Abrams et al., Proc Intern.Symp. on Lepton and Photon Interaction (Stanford,1975)
3. V.A.Novikov and M.A.Shifman, Z.Phys.C8(1981)43
4. S.Nussinov,Phys.Rev.Lett.35(1976)1672