

# $\Upsilon(1D)$

$$I^G(J^{PC}) = 0^-(2^{--})$$

First observed by BONVICINI 04 in the decay to  $\gamma\gamma \Upsilon(1S)$  and confirmed by DEL-AMO-SANCHEZ 10R in the decay to  $\pi^+\pi^- \Upsilon(1S)$ . Data consistent with  $J^P = 2^-$ . The states with  $J = 1$  and 3 also possibly seen, but need confirmation.

## $\Upsilon(1D)$ MASS

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>10163.7 ± 1.4 OUR AVERAGE</b>		Error includes scale factor of 1.7.		
10164.5 ± 0.8 ± 0.5		DEL-AMO-SA...10R	BABR	$\Upsilon(3S) \rightarrow \gamma\gamma\pi^+\pi^-\ell^+\ell^-$
10161.1 ± 0.6 ± 1.6	38	BONVICINI 04	CLE3	$\Upsilon(3S) \rightarrow 4\gamma\ell^+\ell^-$

## $\Upsilon(1D)$ DECAY MODES

Mode	Fraction ( $\Gamma_i/\Gamma$ )
$\Gamma_1 \quad \gamma\gamma \Upsilon(1S)$	seen
$\Gamma_2 \quad \gamma\chi_{bJ}(1P)$	seen
$\Gamma_3 \quad \eta \Upsilon(1S)$	not seen
$\Gamma_4 \quad \pi^+\pi^- \Upsilon(1S)$	$(6.6 \pm 1.6) \times 10^{-3}$

## $\Upsilon(1D)$ BRANCHING RATIOS

<b><math>\Gamma(\eta \Upsilon(1S))/\Gamma(\gamma\gamma \Upsilon(1S))</math></b>	<b><math>\Gamma_3/\Gamma_1</math></b>
<u>VALUE</u>	<u>CL%</u>
<b>&lt;0.25</b>	90
<u>DOCUMENT ID</u>	<u>TECN</u>
BONVICINI 04	CLE3
<u>COMMENT</u>	
$\Upsilon(3S) \rightarrow 4\gamma\ell^+\ell^-$	

<b><math>\Gamma(\pi^+\pi^- \Upsilon(1S))/\Gamma_{\text{total}}</math></b>	<b><math>\Gamma_4/\Gamma</math></b>
<u>VALUE (units <math>10^{-2}</math>)</u>	<u>DOCUMENT ID</u>
<b><math>0.66^{+0.15}_{-0.14} \pm 0.06</math></b>	<sup>1</sup> DEL-AMO-SA...10R
	BABR
	<u>COMMENT</u>
	$\Upsilon(3S) \rightarrow \gamma\gamma\pi^+\pi^-\ell^+\ell^-$

<sup>1</sup> Using theoretical predictions for  $B(\chi_{bJ}(2P) \rightarrow \gamma \Upsilon(1D))$ .

<b><math>\Gamma(\pi^+\pi^- \Upsilon(1S))/\Gamma(\gamma\gamma \Upsilon(1S))</math></b>	<b><math>\Gamma_4/\Gamma_1</math></b>
<u>VALUE</u>	<u>CL%</u>
<b>&lt;1.2</b>	90
<u>DOCUMENT ID</u>	<u>TECN</u>
<sup>2</sup> BONVICINI 04	CLE3
<u>COMMENT</u>	
$\Upsilon(3S) \rightarrow 4\gamma\ell^+\ell^-$	

<sup>2</sup> Assuming  $J = 2$ .

## $\Upsilon(1D)$ REFERENCES

DEL-AMO-SA... 10R	PR D82 111102	P. del Amo Sanchez <i>et al.</i>	(BABAR Collab.)
BONVICINI 04	PR D70 032001	G. Bonvicini <i>et al.</i>	(CLEO Collab.)