

Charm meson spectroscopy and decays

Belle results/plans for Legacy Book

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- **Contents:**
- Spectroscopy of D_J and D_{sJ} from continuum and B decays
- Decays of D^{**} and D_{sJ}
- Rare D_s and D decays
- Semileptonic and leptonic decays of D and D_s
- Hadronic D and D_s decays

- **Overlap with other sections:**
- D-mixing and CPV
- Dalitz analyses
- B to charm decays

Charm meson spectroscopy

Topic	Existing result	Update/New for $L \sim 1 \text{ab}^{-1}$	Motivation
$D^{**0} \rightarrow D^{(*)+} \pi^-$ in $B^- \rightarrow D^{**0} \pi^-$	PRD 69, 112002 (2004) for 60fb^{-1}	✓ ?	M, Γ , J^{PC} , BF Test of potential models, QCD sum rules and HQET
$D^{**+} \rightarrow D^{(*)0} \pi^+$ in $B^0 \rightarrow D^{**+} \pi^+$	PRD 76, 012006 (2006) for 357fb^{-1} $D^{**} \rightarrow D \pi$ BELLE-CONF-0460 for 140fb^{-1} $D^{**} \rightarrow D^* \pi$	✓ ?	as above
Other decays, properties of D^{**}	PRL 94, 221805 (2005) for 140fb^{-1} $D^{**} \rightarrow D^{(*)} \pi \pi$	✓	as above
Higher excitations	✗	✓	as above

✓ ? = Likely

✗ ? = Unlikely

Charmed-strange meson spectroscopy

Topic	Existing result	Update/New for $L \sim 1 \text{ ab}^{-1}$	Motivation
$D_{s0}^*(2317)$ $D_{s1}(2460)$ in continuum	PRL 97, 061804 (2006) for 282 fb^{-1}	✓ ?	M, Γ , J^{PC} , BF, exotics Test of potential models, QCD sum rules and HQET
$D_{s0}^*(2317)$ $D_{s1}(2460)$ in B decays	PRL 91, 262002 (2003) for 114 fb^{-1}	✓ ?	as above
Other decays, properties of D_{sJ}	PRD 77, 032001 (2008) for 462 fb^{-1} $D_{s1}(2536)$ PWA	✓	as above
Higher excitations	PRL100, 092001 (2008) for 414 fb^{-1} $D_{sJ}(2700)$	✓	as above

✓ ? = Likely

✗ ? = Unlikely

Semileptonic and leptonic decays of $D_{(s)}$

Topic	Existing result	Update/New for $L \sim 1 \text{ ab}^{-1}$	Motivation
$D^0 \rightarrow K l \nu, \pi l \nu$	PRL 97, 061804 (2006) for 282 fb^{-1}	✓ ?	pseudoscalar form factor $f_+(q^2)$, BF, V_{cs}/V_{cd} , test of LQCD
$D^0 \rightarrow \phi l \nu, K^* l \nu$	✗	✓ ?	Vector form factors $V(q^2), A_1(q^2), A_2(q^2)$
$D_s \rightarrow \mu \nu$	PRL 100, 241801 (2008) for 548 fb^{-1}	✓ ?	f_{D_s} decay constant, BF, test of LQCD
$D_s \rightarrow \tau \nu$	✗	✗ ?	f_{D_s} decay constant, BF, NP
$D^+ \rightarrow \mu \nu$	✗	✗ ?	f_D decay constant, f_D/f_{D_s}

✓ ? = Likely

✗ ? = Unlikely

Rare decays of $D_{(s)}$

Topic	Existing result	Update/New for $L \sim 1 \text{ ab}^{-1}$	Motivation
$D^0 \rightarrow \mu^+ \mu^-$, $e^+ e^-$, $\mu^+ e^-$	BELLE-CONF-0926 for 659 fb^{-1}	✓ ?	NP
$D^0 \rightarrow \phi \gamma$	PRL 92, 101803 (2004) for 78 fb^{-1}	✗ ?	Long-distance effects, NP
$D \rightarrow K ^+ ^-, \pi ^+ ^-$	✗	✓ ?	NP, A_{FB}
$D \rightarrow K^* \gamma$	✗	✗ ?	Long-distance effects, NP

✓ ? = Likely

✗ ? = Unlikely

Hadronic decays of $D_{(s)}$

Topic	Existing result	Update/New for $L \sim 1 \text{ ab}^{-1}$	Motivation
$D^+_{(s)} \rightarrow K_s K^+, K_s \pi^+$	arXiv:0910.3052 (\rightarrow PRD) for 673 fb^{-1}	✗ ?	BF, test of SU(3), CPV
$D^+_s \rightarrow K^+ K^+ \pi^-$ $D^+ \rightarrow K^+ \pi^+ \pi^-$	PRL 102, 221802 (2009) for 605 fb^{-1}	✗ ?	BF, test of SU(3)
$D^0 \rightarrow \pi^+ \pi^- \pi^0$	PLB 662, 102 (2008) for 288 fb^{-1}	✓ ?	BF, Dalitz analysis, mixing, CPV
$D^0 \rightarrow K_s \pi^+ \pi^-$	PRL 99, 131803 (2007) for 540 fb^{-1}	✓ ?	BF, Dalitz analysis, mixing, CPV
$D^0 \rightarrow K^+ \pi^-$	PRL 96, 151801 (2006) for 400 fb^{-1}	✓ ?	BF, mixing, CPV
$D^0 \rightarrow K^+ \pi^- \pi^0,$ $K^+ \pi^+ \pi^- \pi^-$	PRL 95, 231801 (2005) for 281 fb^{-1}	✓ ?	BF, mixing, CPV
Other decay modes		✓ ~3	(Absolute) BF, Dalitz analyses, CPV

✓ ? = Likely

✗ ? = Unlikely