

Table of Contents

| | |
|---|-----|
| Heavy quarkonium: progress, puzzles, and opportunities | 1 |
| <i>N. Brambilla et al.</i> | |
| 1 Introduction..... | 3 |
| 2 Spectroscopy | 6 |
| 2.1 Conventional vectors above open-flavor threshold..... | 7 |
| 2.2 Newly found conventional quarkonia | 11 |
| 2.3 New unanticipated states | 17 |
| 2.4 Characteristics of quarkonium systems..... | 28 |
| 2.5 Nonrelativistic effective field theories | 30 |
| 2.6 Lattice QCD spectrum calculations..... | 32 |
| 2.7 Predictions for the $\eta_b(1S)$ mass..... | 35 |
| 2.8 Standard Model parameter extractions..... | 35 |
| 2.9 Exotic states and states near or above threshold | 38 |
| 2.10 Beyond the Standard Model | 51 |
| 3 Decay..... | 54 |
| 3.1 Radiative transitions..... | 54 |
| 3.2 Radiative and dileptonic decays..... | 61 |
| 3.3 Hadronic transitions..... | 68 |
| 3.4 Hadronic decays | 76 |
| 4 Production | 81 |
| 4.1 Introduction to theoretical concepts | 81 |
| 4.2 Production at the Tevatron, RHIC and the LHC..... | 86 |
| 4.3 $e\bar{p}$ collisions | 97 |
| 4.4 Fixed-target production | 101 |
| 4.5 Exclusive production in e^+e^- collisions | 103 |
| 4.6 Inclusive production in e^+e^- collisions | 105 |
| 4.7 B_c production | 109 |
| 5 In medium | 113 |
| 5.1 Quarkonia as a probe of hot and dense matter | 113 |
| 5.2 Cold-nuclear-matter effects | 113 |
| 5.3 Quarkonium in hot medium | 116 |
| 5.4 Recent results at SPS energies | 120 |
| 5.5 Recent hadroproduction results from RHIC | 122 |
| 5.6 Anomalous suppression: SPS vs. RHIC | 127 |
| 5.7 Photoproduction in nuclear collisions | 127 |
| 6 Experimental outlook..... | 130 |
| 6.1 BESIII..... | 130 |
| 6.2 ALICE | 131 |
| 6.3 ATLAS | 134 |
| 6.4 CMS..... | 138 |
| 6.5 LHCb | 142 |
| 6.6 RHIC..... | 144 |
| 6.7 Super flavor factories | 145 |

| | | |
|------|--|------------|
| 6.8 | \bar{P} ANDA | 146 |
| 6.9 | CBM at FAIR | 151 |
| 6.10 | Tau-charm factory in Novosibirsk..... | 152 |
| 6.11 | Charmonium photoproduction facilities..... | 152 |
| 6.12 | Proposed $\bar{p}p$ project at Fermilab | 155 |
| 6.13 | Future linear collider | 156 |
| 7 | Conclusions and priorities..... | 158 |
| | Acknowledgements | 162 |
| | References | 163 |
| | Properties of the top quark | 179 |
| | <i>D. Wicke</i> | |
| 1 | Introduction..... | 179 |
| 1.1 | Theory..... | 180 |
| 1.2 | Experiments..... | 184 |
| 1.3 | Basic event selection | 186 |
| 2 | Top quark mass measurements | 187 |
| 2.1 | Theoretical aspects | 187 |
| 2.2 | Lepton plus jets channel | 188 |
| 2.3 | Dilepton channel..... | 197 |
| 2.4 | All hadronic channel..... | 203 |
| 2.5 | Top quark mass from cross-section..... | 206 |
| 2.6 | Modelling of non-perturbative effects..... | 207 |
| 2.7 | Combination of top quark mass results | 207 |
| 2.8 | Mass difference between top and antitop quark..... | 207 |
| 2.9 | Conclusions and outlook to LHC | 209 |
| 3 | Interaction properties | 210 |
| 3.1 | W boson helicity | 210 |
| 3.2 | The CKM element V_{tb} | 214 |
| 3.3 | Flavour changing neutral currents..... | 217 |
| 3.4 | Top quark charge..... | 219 |
| 3.5 | Spin correlations..... | 222 |
| 3.6 | Charge forward-backward asymmetry | 224 |
| 3.7 | Differential cross-section..... | 226 |
| 3.8 | Gluon production vs. quark production..... | 227 |
| 3.9 | Top quark width and lifetime | 229 |
| 3.10 | Outlook to LHC..... | 230 |
| 4 | New particles in top quark events | 231 |
| 4.1 | Associated Higgs boson production, tH | 231 |
| 4.2 | Charged Higgs boson | 231 |
| 4.3 | Heavy charged vector boson, W' | 235 |
| 4.4 | Resonant top quark pair production | 237 |
| 4.5 | Admixture of stop quarks | 242 |
| 4.6 | Heavy top-like quark, t' | 245 |
| 4.7 | Outlook to LHC..... | 247 |
| 5 | Conclusions | 248 |
| | Acknowledgements | 249 |
| | References | 249 |