Standard Model

Determination of the bottom quark mass from the $\Upsilon(1S)$ mass and perturbation theory

At present the major theoretical error comes from the ultrasoft non-perturbative corrections to the $\Upsilon(1S)$ mass. They are a function of the chromoelectric gluonic correlator.

Action Items:

- It is important to compute the chromoelectric gluonic correlator in the lattice as precisely as possible. Obviously unquenched computations would be most welcome.
- It would also be necessary to obtain the change of scheme from the lattice to the MS scheme in order to relate the lattice with the perturbative result.

Determination of the bottom (charm) quark mass from non-relativistic sum rules

Non-relativistic sum rules may give accurate determinations of the bottom quark mass. Nevertheless, a continued effort is necessary to improve the theoretical and experimental results.

Action Items:

- A complete NNLL computation would be most welcome to have a better estimate of the theoretical uncertanties.
- A complete NNNLO computation would be most welcome to have a better estimate of the theoretical uncertanties. Moreover, it would help to assess the importance of the resummation of logarithms.
- Expressions for the non-perturbative corrections when $m/n \sim \Lambda_{QCD}$, as well as estimates.
- For low moments a better experimental data for b-$\bar{b}$ production above threshold would be most welcome to diminish the experimental error. In this respect, CLEO is close to complete the R measurement in the prebottomonium region from 7 to 10 GeV while Belle made a new run on the Upsilon(5S).
- One may try to perform a similar (experimental/theoretical) analysis for charmonium. In this respect there are new R measurements in the precharmonium region with BES at BEPC in Beijing, China and just above the charm threshold with CLEO at CESR in Cornell, USA. These provide important input to the determinations of the charm quark mass.

Determination of the bottom quark mass from the Υ spectrum and lattice QCD

At present the major theoretical error comes from the conversion from the bare lattice mass to a familiar scheme, such as $\overline{\text{MS}}$.

Action Items:

- It is essential to compute the two-loop matching in lattice NRQCD, and also in the Fermilab method for heavy quarks.
- It is important to extend the Fermilab method to eliminate (tree-level) discretization effects in interactions affecting the spectrum at order v^6. (This step is expected to be completed soon.)

- Because lattice QCD uses essentially the same Lagrangian for heavy-light mesons and quarkonium, a cross-check with the bottom mass from the B_s is valuable.
- Nonperturbative matching is preferable to fixed-order perturbative matching, provided that other errors, such as quenching or higher-power effects are demonstrably under control.

Determination of the charmed quark mass from the ψ spectrum and lattice QCD

At present the major theoretical error comes from the conversion from the bare lattice mass to a familiar scheme, such as $\overline{\mathrm{MS}}$.

Action Items:

- It is essential to compute the two-loop matching in the Fermilab method for heavy quarks, and also in new formalisms that work when $m_c a \ll 1$.
- It is important to extend the Fermilab method to eliminate (tree-level) discretization effects in interactions affecting the spectrum at order v^6. (This step is expected to be completed soon.)
- Because lattice QCD uses essentially the same Lagrangian for heavy-light mesons and quarkonium, a cross-check with the bottom mass from the D_s is valuable.
- Nonperturbative matching is preferable to fixed-order perturbative matching, provided that other errors, such as quenching or higher-power effects are demonstrably under control.

Determination of the strong coupling α_s from the quarkonium spectrum and other quantities in lattice QCD

Confidence in the current result could increase once a different formulation of sea quarks has produced a consistent set of results for a wide range of observables (as with staggered sea quarks). The error in α_s will not be reduced until $\Lambda_{\overline{\mathrm{MS}}}$ has been determined nonperturbatively with 2+1 or 2+1+1 sea quarks. (Here 2 flavors are much lighter than strange; another is tuned to strange; perhaps another to charm.)

Action Items:

- Generate large ensembles of lattice gauge fields with 2+1 or 2+1+1 Wilson, domain-wall, or overlap sea quarks.
- Analyze a wide variety of gold-plated observables, including the charmonium, bottomonium, and heavy-light spectrum.
- Trace the evolution of α_s nonperturbatively, deeply enough into the perturbative regime to extract the Λ-parameter and convert to $\Lambda_{\overline{\mathrm{MS}}}$.

t-$\bar{t}$ production near threshold

One can obtain very good determinations of the top mass as well as the top Yukawa coupling from an eventual scan of the t-$\bar{t}$ production near threshold at the International Linear Collider.

Action Items:

- A complete NNLL computation would be most welcome to have a better estimate of the theoretical uncertanties.

- A complete NNNLO computation would be most welcome to have a better estimate of the theoretical uncertanties. Moreover, it would help to assess the importance of the resummation of logarithms.
- Computation of the electroweak and non-factorizable corrections. In the long term development of the effective theory for unstable particles.

$\Upsilon(1S)/\eta_b(1S)$ inclusive decays

For a comprehensive understanding of the ground state of the bottomonium system as a mainly perturbative system it is necessary to understand the lack of convergence of the perturbative series for those decays.

Action Items:

- A complete NNLL computation would be most welcome to have a better estimate of the theoretical uncertanties.
- A complete NNNLO computation would be most welcome to have a better estimate of the theoretical uncertanties. Moreover, it would help to assess the importance of the resummation of logarithms.
- Estimate of the non-perturbative corrections. They also depend on the same chromoelectric gluonic correlator than the $\Upsilon(1S)$ mass.
- Rearrangement (renormalon-based?) of the perturbative series.

Determination of the tau lepton mass

The major difficulty for improving the mass of the tau lepton mass comes from the experimental side. At this respect, there are new high precision measurements of the tau lepton mass performed with KEDR at VEPP-4M in Novosibirsk, Russia and Belle at KEKB in Tsukuba, Japan. A more precise value of the mass gives input to the test of the lepton universality.