Many (all) the questions have been answered during the Q&A period. Nevertheless, we ask that you provide written answers below so students can come back to read them again. Thanks!

1. Relating to CPT violation, could we ever distinguish a particle that is fermion-boson mixture?

   Yes, mixed spins would leave clear signatures in our observations. For example, in angular distributions, CPT tests, etc.

2. How are the quark parameters, for example the quark mass, measured?

   Quark masses influence the rates at which scattering process occur. In our predictions for the outcome of scattering processes we can vary the mass of particles and find the best fit as a function of the mass to experimental observation. For example, for the top quark, we can simply ask how many top quarks are produced at the LHC and the answer will change as a function of the top quark mass, simply because I will need more or less energy to produce the top

3. (Page 13) The x used in this slide, is it same as Bjorken scaling variable? In other words, is the fraction of the total momentum carried by partons Bjorken scale?

   x here is simply the fraction of the momentum of the proton P the parton carries. Parton momentum p= x P

4. (Page 14) I have an ambiguity on the proton momentum fraction carried by the gluon: is it bigger than 40% or equal to 33%

   The fraction of the proton momentum carried by the gluon varies as a function of Q. At Q=1GeV, it's about 33%.

5. (page 19) Can you explain again the difference between electron and positron? Why is there a difference when it is a virtual photon that interacts with partons?

   The electron and positron have different weak charges which leads to different cross sections at high Q when the scattering process becomes dominated by the exchange of a Z boson instead of a photon

Positrons: For the exchange of a photon, positrons and electrons look identical but for a Z boson, different charges are involved. Anti-protons are very similar to protons but the fractions of partons inside the proton change around. The up-quark PDF becomes the anti-up quark PDF, the down becomes the anti-down, etc. and the gluon stays the same.

6. (Page 59) This uncertainty breakdown appears to be for the NNLO calculation (~10% at 13 TeV). Is the breakdown similar for the N^3LO calculation?

   The lowest shaded area on this slide represents the uncertainty due to the truncation fo the perturbative expansion at N3LO. The other shaded areas arise from other sources of uncertainty (PDFs, mass effects, electro-weak effects …). Here, the perturbative uncertainty is about 2-3%, whereas it was about 10% if truncated the perturbative series at NNLO.

7. its possible to consider the top quark as a composite particle for some models? What consequences would we find?

   Yes, absolutely. However, we are already constraining the compositeness of the top quark quite a bit. High accuracy scattering data at the Tevatron and the LHC allow us to probe the structure of the top quark and so far we find excellent agreement with the top quark being and elementary point particle.