Maurice the enthusiast

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I was privileged to know Maurice Jacob for more than 35 years, to enjoy the warm hospitality he and Lise offered at their house, and to meet him at various places around the world -- he was an enthusiastic traveller.

He was also enthusiastic about all things British: Scottish whisky, the adventures of Harry Potter and, after I had introduced him to it, the music of Edward Elgar, are some examples. On one occasion his being an anglophile avoided what might have been an awkward international incident. As President of the French Physical Society he was entertained to a formal dinner by the Institute of Physics in Britain. Unfortunately, and I am sure completely unintentionally, the IoP had arranged for it to be held in a hotel and when they arrived there they discovered that the dinner was laid out in its Waterloo Room. Maurice told me about it with great amusement.

For many years he was a very dedicated editor of Physics Letters, and in due course I followed him in that. He did not completely agree with my approach to the journal: I would tell my referees that the most important thing was that papers should be interesting, while Maurice laid rather more stress on “importance”. In 1997 he invited me to a conference he was organising in Stockholm on the future of academic publishing; we shared a concern, which I still have, that the changes made possible by the advances of technology must produce a system that is robust enough to last into the indefinite future.

Of course high energy physics was Maurice’s great passion and over the years we worked together on different topics:

- J/psi production
- Large p_T and jets
- Thermal field theory

The work on J/psi production came about when Maurice visited me in Cambridge in1974 just after the J/psi had been discovered. In a very short time a huge number of papers had been written speculating on what the J/psi was and how it was produced. We talked in the DAMTP coffee room to Michael Green, who has since become famous as a string theorist, and then wrote a paper together[1], Our approach was to suppose that the J/psi is not composed just of charmed quarks, but also has a significant light-quark component. This was confirmed in 1977 by the Omega experiment, which found[2] that at the low energies available then antiproton beams colliding with a nuclear target produced 6 times as many J/psi as did proton beams. We supposed also that the nucleon has what nowadays would be called a significant intrinsic charm component.

While we did not get the details right, I still believe there was some truth in what we wrote. Certainly, today's conventional approach to charm production needs refinement. These are charm-production data from electron scattering experiments at HERA:

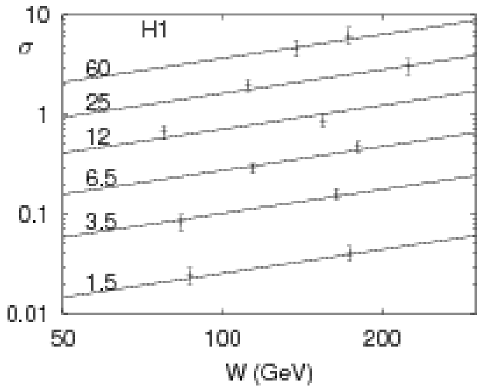


Figure 1: Total cross section for photoproduction of charm at various Q^2

At all Q^2 the charm photoproduction varies as the same fixed power near 0.8 of the centre-of-mass energy W. This is very different from inclusive photoproduction, where the power is also not far from 0.8 at large Q^2, but is less than 0.2 at small Q^2

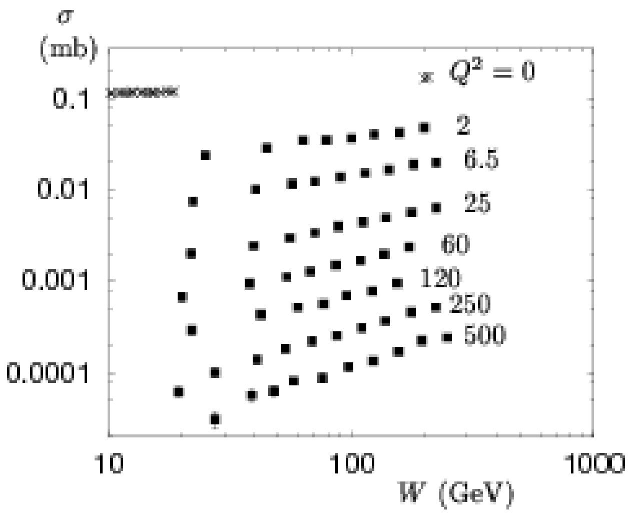


Figure 2: Total photoproduction cross section

Sandy Donnachie and I have explained this[3,4] by saying that a combination of two exchanges, called the soft and the hard pomerons, is responsible for this behaviour. Soft-pomeron exchange corresponds to the fixed power of *W* less than 0.2, while hard-pomeron exchange gives a fixed power close to 0.8. We have successfully used this picture to describe a large range of hadronic cross sections. Maurice was always very interested to talk to me about the pomerons, but I think that he found them slightly amusing, though of course he was much too polite to tell me that.

Maurice and I wrote several review articles together. *Large transverse momentum and jet studies*[5] appeared in Physics Reports in 1978. It included a figure showing what jets looked like in experiments then (left-hand picture in the figure below). By the time another of our reviews, *Deep inside matter*[6], appeared less than a decade later, jets were a much more prominent feature of the final state in experiments at CERN under appropriate trigger conditions (right-hand picture).

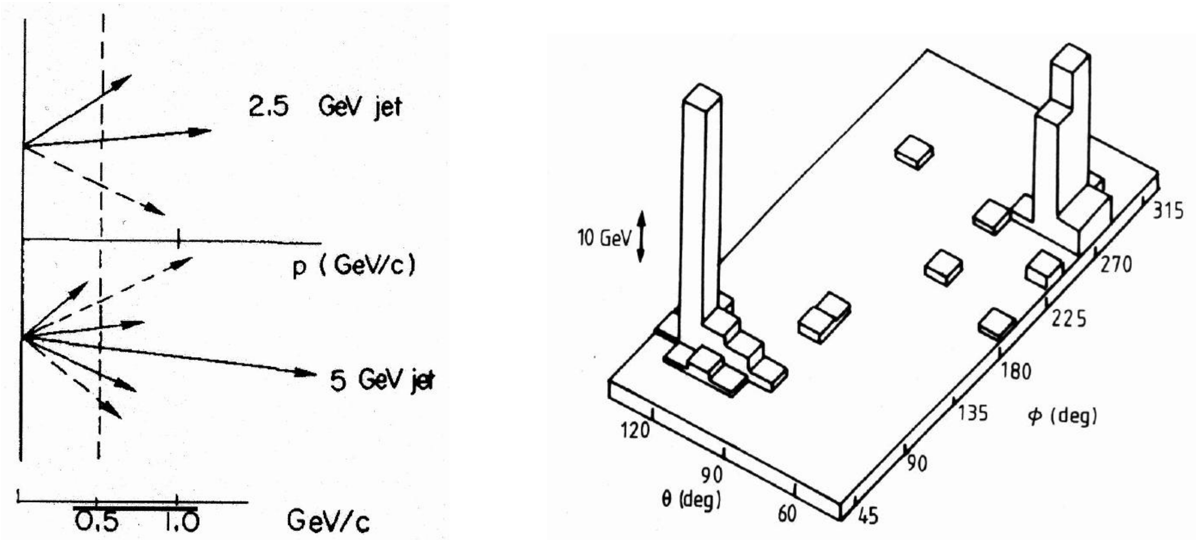


Figure 3: Jets in 1978 and 1987

Another figure in our 1978 review showed data for large-angle elastic *pp* scattering, which were already showing interesting features:

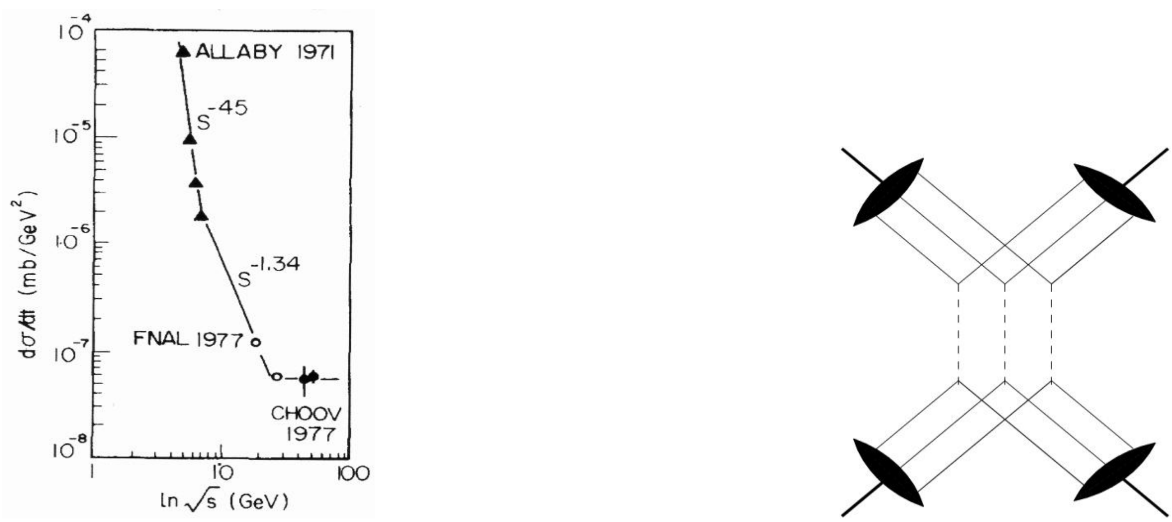
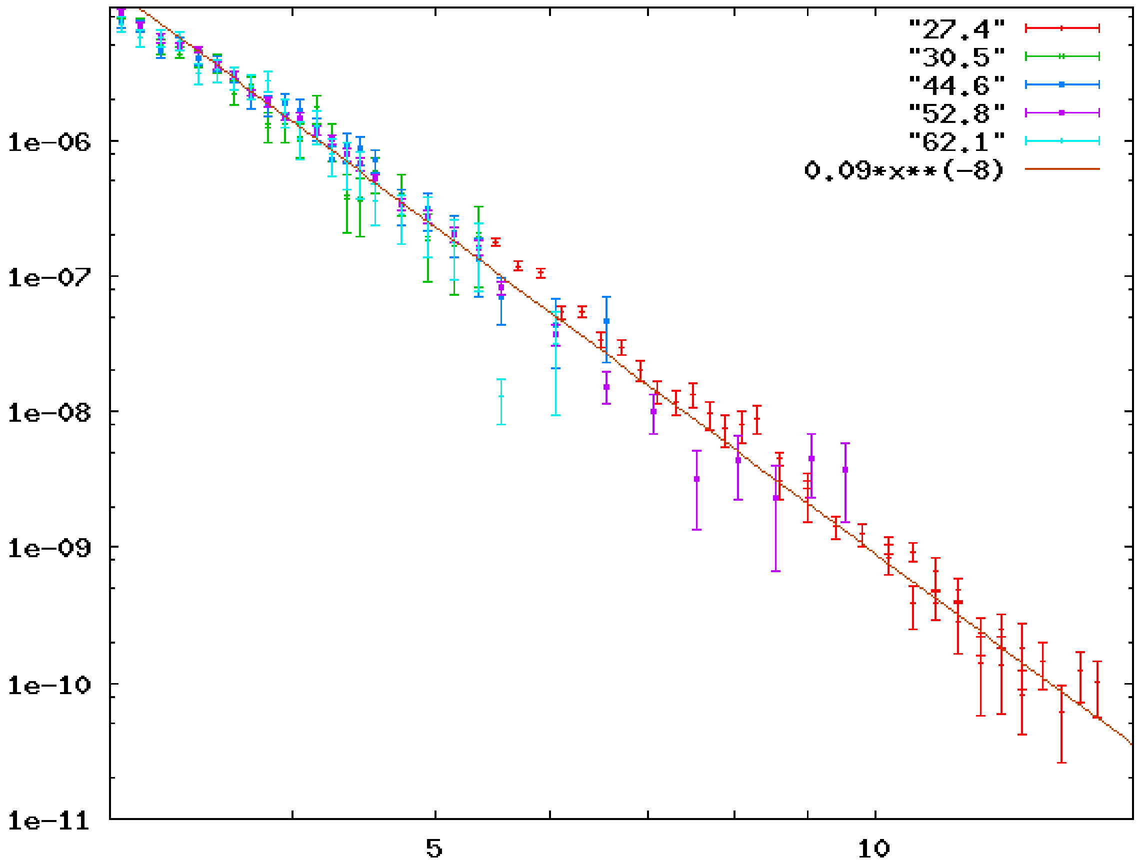


Figure 4: Data in 1978 for elastic *pp* scattering at $-t$=6 GeV^2, with the triple-gluon-exchange mechanism

At high enough energy, according to present data, the differential cross section becomes independent of energy and behaves as a fixed power -8 of the momentum transfer *t*: This behaviour is just what is obtained from the exchange of three gluons between the two interacting protons, at least when it is calculated to lowest order in perturbative QCD. This raises an interesting question[7]: what if we replace the gluons with the hard pomeron? This gives a mechanism that presumably is too small to detect at present energies, but it rises rapidly with increasing energy and so it may well be that at LHC energy large-*t* elastic scattering is much larger than many people expect.



|*t*| (GeV)^2

Figure 5: Present data for the differential cross section for large-*t* *pp* elastic scattering at various energies

In our 1987 review[6] we also showed how the high-energy data for the proton-proton and proton-antiproton total cross sections were described well by soft-pomeron exchange, that is they rose as a power of *s* a little less than 0.1. At that time the highest available energy was at the CERN proton-antiproton collider. There is a significant disagreement between the experiments[8] that have subsequently measured the cross section at the Tevatron. If the higher value, from CDF, should turn out to be correct, this is a clear signal that some new mechanism has become important. An obvious candidate is hard-pomeron exchange. Including this gives a good fit[9], but there is a theoretical problem if one wants to extrapolate this fit to LHC energy. One knows that a fixed power can only be an approximation, if only because at higher energies it would make the elastic cross section greater than the total cross section. The remedy is to include so-called unitarity corrections but, although the eikonal model is a popular approach to doing this, we have no well-founded way to do the calculation. In the figure above, the upper curve is the extrapolation with no unitarity correction. The centre curve is my best attempt[10] at including a unitarity correction and the lowest curve is the fit with no hard-pomeron contribution.

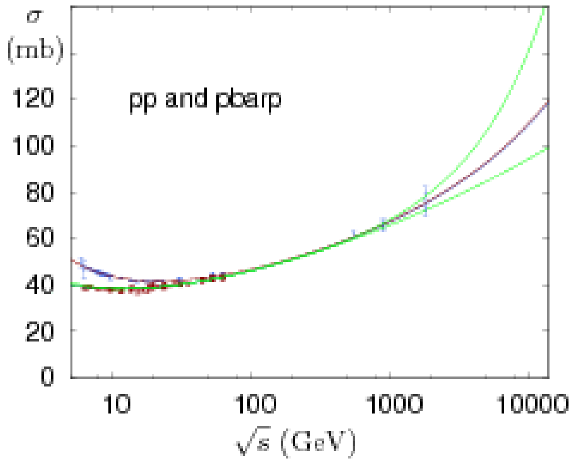


Figure 6: Total cross sections with different fits extrapolated to LHC energy

So the error in the prediction is very large, say

125 +/- 25 mb

The last paper Maurice and I wrote together appeared in Physics Letters B in 1992 and was called *Reaction rate in a heat bath*[11]. I wrote several other papers on thermal field theory after this, and they were strongly influenced by this work with Maurice. What I learnt from him is that in this area one should always go back to first principles, and if one does so one often makes interesting discoveries that come as a surprise to the experts.

If I were to sum up what I learnt from Maurice over the years I worked and played with him, it would be

- Everything is interesting
- If you are trained as a physicist, you can do anything

It is so sad that he will not be with us to share in the excitement of the discoveries that will come from the LHC.

References

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