

Physics monitor

Elastic scattering

With very few unexplained results to challenge conventional ideas, physicists have to look hard to search for gaps in understanding.

An area of physics which offers a lot more than meets the eye is elastic and diffractive scattering – where particles either ‘bounce’ off each other, emerging unscathed, or just graze past, emerging relatively unscathed.

The ‘Blois’ workshops (named after a favourite French venue) provide a regular focus for this unspectacular, but compelling physics, attracting highly motivated devotees.

Unfortunately solid new results in this area are rare these days, but this year’s meeting in La Biodola, Sardinia, had new experimental results to digest. The proton-antiproton reaction rate (total cross-section) at 1800 GeV collision energy, measured by two groups at Fermilab, is smaller than some people expected.

This reaction rate depends on the imaginary part of the forward scattering amplitude. Measurements at 1800 GeV moreover suggest the ratio of the real and imaginary parts (ρ) of this amplitude to be smaller than expected.

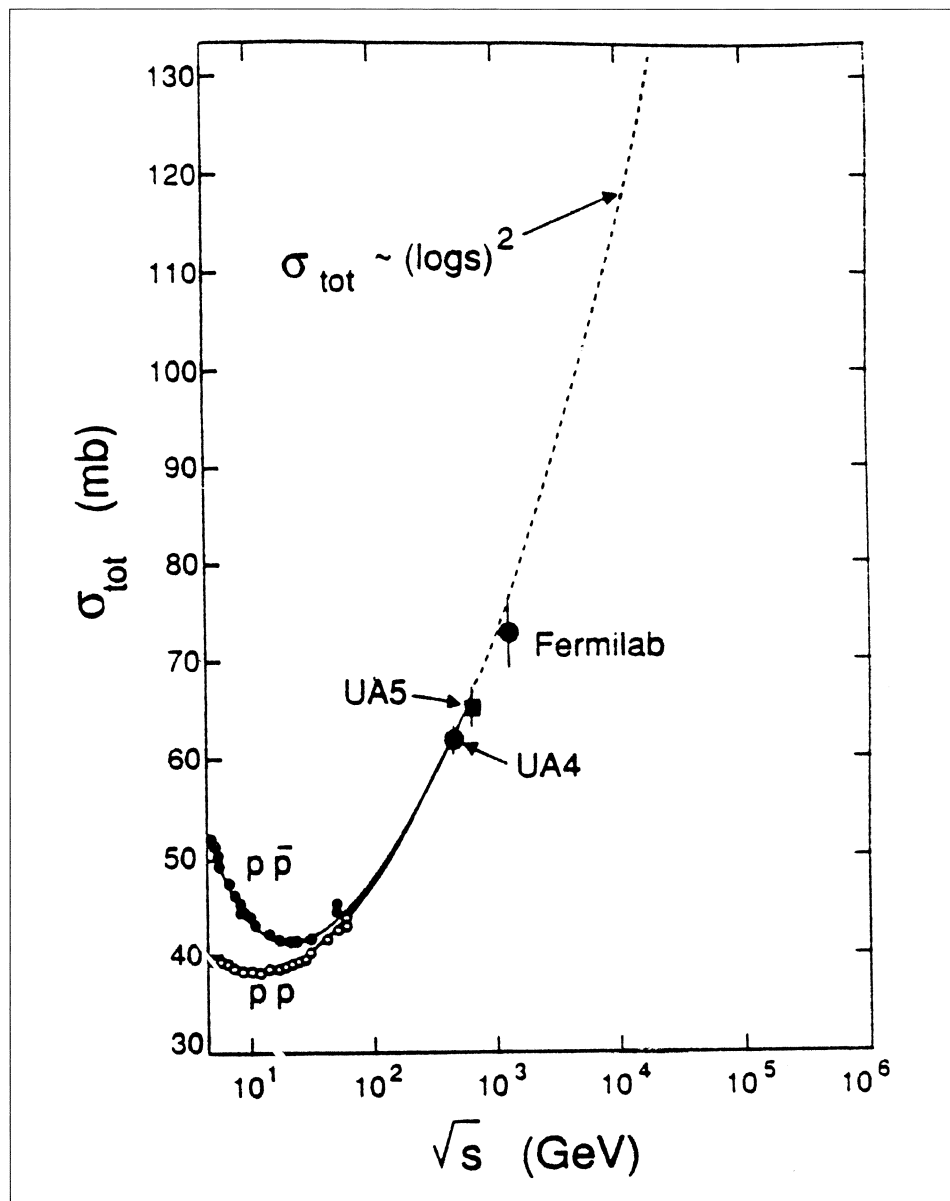
Attention also focused on the ‘Pomeron’ – the mechanism driving elastic scattering, and the ‘Odderon’ – an analogous way of explaining the continued difference between proton-proton and proton-antiproton behaviour at high energies.

With the prospect of a new energy scale opening up with the next generation of proton colliders, J.D. Bjorken argued at the Blois meeting that the programme at the planned US SSC Superconducting Supercol-

lider is too narrowly focused on the high energy frontier, especially the ‘Higgs’ mechanism of electroweak symmetry breaking, at the expense of unbiased ‘survey physics’.

Low energy effects might not seem the most exciting part of a new high energy programme, but sensitivity also increases with energy. Bjorken is pushing for a long spectrometer to study soft physics at the SSC.

Total reaction rate (cross-section) for proton-proton and proton-antiproton reactions, where the latest result from Fermilab, probing a new energy region, suggests that the rate of increase with energy might not be as rapid as was originally thought.



(The report of the July meeting of the SSC Program Advisory Committee says – ‘At this time an experimental collaboration does not exist and the cost of the fully instrumented detector is too high for the initial SSC program. However in view of the possible interest in this type of experiment at some stage of SSC operation the Committee supports the study of a suitable 1-kilometre enlarged tunnel in the

SSC design where a wide class of experiments such as this one could be carried out.)

On the theoretical side, the Blois meeting could report much progress in the kinematic region where the perturbative field theory (QCD) of quarks and gluons is not directly applicable.

In experiment, one challenge is to find whether the Odderon really exists. Because the Pomeron normally dominates, this means looking at reactions where the Pomeron is absent – pion conversion to rho mesons in fixed target work, for example.

In total cross-sections, the new 1800 GeV proton-antiproton data from Fermilab is the latest episode in a long saga. Before 1968, the general belief was that total cross-sections were smoothly approaching some kind of constant asymptotic limit. CERN's Intersecting Storage Rings, opening up a new energy region, quickly showed otherwise. This surprise was underlined by new understanding, showing that the behaviour in-

creased at the maximal rate allowed by a healthy theory, going as the square of the logarithm of the collision energy.

Another widespread belief was that particle and antiparticle differences would iron out at higher energy. At CERN's proton-antiproton collider, the UA4 experiment's rho result suggested that things could be more complicated.

This measured value can be accommodated either by anticipating a rapid increase in the proton-antiproton reaction rate beyond the CERN Collider energies – a 'New Threshold' scenario – or by calling up the Odderon. Clearly the higher energy results from the Tevatron are crucial in choosing between these two alternatives.

However measuring a total cross-section at a collider is not that easy. At Fermilab, experiment E710 and the CDF collider now agree that the proton-antiproton total cross-section is about 72.6 ± 3.5 millibarns at 1800 GeV. This value certainly eliminates the New Threshold Scenario and is even

hard to achieve with Odderons. The extrapolation from the ISR to the Tevatron now also looks different.

Even more difficult to measure is rho. The scattering angles are so small that the scattered beam overlaps the divergence of the unscattered particles. Special detectors ('Roman pots') extend into the beampipe.

It is not easy for the central UA4 and E710 results to coexist, although some theorists have risen to the challenge. With the situation so uncertain, elastic scattering will continue to draw an appreciative audience.

From Elliot Leader

Tau neutrino no heavyweight?

The decay patterns of the Z particle – the electrically neutral carrier of the weak force, dominated by the information from the four big experiments – Aleph, Delphi, L3 and Opal – at CERN's LEP electron-positron collider, have shown that only three types of light, conventional neutrino can exist.

This important result confirmed what many physicists had long hoped for – a neat picture of fundamental interactions in terms of six types of quark, grouped pairwise with three types of weakly interacting particles (leptons).

But particle physics – the study of the infinitesimally small – has become intrinsically linked with



The ARGUS experiment at DESY's DORIS II electron-positron collider has supplied useful limits on the mass of the tau neutrino.