The pattern can give us information about global properties (size, shapes, colors, and so on), and this can be useful for testing hypotheses. For example, if we observe a pattern that is not expected (or is unexpected), we can conclude that there is a difference in the underlying physics.

In fact, the most characteristic feature of a diffraction process is a difference in intensity between different angles. This difference is usually small, but when it is large, it can be detected in the on-shell case. The intensity of the pattern is given by the square of the scattering amplitudes, and the intensity is proportional to the product of the scattering amplitudes. The scattering amplitudes are complex numbers, and the intensity is given by the square of the magnitude of the scattering amplitudes.

1. Hard process in general, and hard scattering in particular, are off-shell. The scattering amplitude is complex, and the intensity is given by the square of the magnitude of the scattering amplitude.
2. The pattern is determined by the product of the scattering amplitudes, and the intensity is proportional to the product of the scattering amplitudes. The scattering amplitudes are complex numbers, and the intensity is given by the square of the magnitude of the scattering amplitude.

In conclusion, the pattern is determined by the product of the scattering amplitudes, and the intensity is proportional to the product of the scattering amplitudes. The scattering amplitudes are complex numbers, and the intensity is given by the square of the magnitude of the scattering amplitude.
shape) of the scatterer ("interaction region"). From intuitive considerations one can think that for off-shell scattering the interaction radius should decrease with growth of virtuality.

- What is the role of unitarity? When asking such a question we mean the following. If one takes some “bare” or “Born” amplitude which is deduced from some simple arguments (say, Regge pole) it often violates unitarity or its consequences (e.g. Froissart–Martin (FM) bound). This is not the reason to abandon such a “wrong” amplitude which is considered to be very good in many other respects. The remedy is “unitarization”, i.e. some infinite summation of the “bare” amplitude which yields a new, good amplitude respecting unitarity etc. The most known examples are eikonal and U-matrix representations.

Discovery of the fast growth of DIS cross-sections at HERA exacerbated the quest of possible unitarity-driven upper bounds.

Such bounds were obtained (see e.g.[5]) but at a price, after making serious extra assumptions which deprive the results of rigour and generality of the FM theorem.

- However the framework of general principles of quantum field theory seem to fairly admit power-like growth of the "off-shell" cross-sections. Extended Regge-eikonal just realizes this possibility in a concrete form. It is interesting to note that cross-sections of exclusive (binary) deeply virtual processes do not exceed the FM limit ($log^2 s$), while the corresponding total cross-sections grow as a power of energy [6]. It means that at extremely high $s$ and $Q^2$ "unitarity effects" for total cross-sections are relatively negligible, while they are 100% important for binary exclusive cross-sections.

A natural interpretation of this phenomenon is that at high $Q^2$ the role of multiple production grows in full accordance with ref [7].

We still lack the results concerning angular distribution of final particles in the binary deeply virtual exclusive processes. At the moment we can only mention the average impact parameter

$$< b^2 > (s, Q^2) \sim log^2 s/logQ^2.$$ 

We see that the transverse interaction region grows asymptotically with
energy (feature familiar from on-shell hadron-hadron processes) and
shrinks with virtuality, $Q^2$, but slower.

At first sight it seems to mean that at equal c.m.s. energies the off-shell
diffractive pattern is shallower and has more wide forward peak. But
at realistic $s$ and $Q^2$ the picture can be much more complicated. We
have to stress that up to now no sign of a dip is seen in the angular
distribution of exclusively produced vector mesons at HERA. One
could take this as an evidence in favour of a $Q^2$-induced spread of the
diffractive pattern.

- The last subject I want to touch is the case when in capacity of a
hard scale we take not the virtuality but the "compactification radius",
$R_c$, assuming in accordance with newest ideas that our space-time
has more than 4 dimensions, and that extra dimensions are somehow
compactified. What is the rôle of a hard scale, $R_c$, in high energy
behaviour? It appears that this rôle is quite insignificant. At least for
the upper bound. One can show [8], that the compactification radius
enters the upper bound (which is FM-like) quite harmfully, and, with a
proper normalization, peacefully disappears in the zero limit bringing
us back to the usual Minkowsky space-time and the FM bound. It
is likely that influence of $R_c$ is more dramatic for high momentum
transfers.

- As a conclusion I have no much to say.

1. Effects of fast growth of DIS cross-section discovered at HERA
remains unexplained.

2. Unitarity does not limit this growth too stringently.

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References


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