Short Communications

Aust. J. Phys., 1978, **31**, 447–9

$\pi^- p \to \eta n$ Scattering at Fermilab Energies

M. Saleem, M. Iftikhar Ahmad and M. Rafique

High Energy Physics Group, Department of Physics, Punjab University, Lahore, Pakistan.

Abstract

By a phenomenological choice of the residue function, a very good fit with experiment is obtained on a simple Regge pole model using a linear A_2 trajectory and energy-independent parameters.

From a theoretical point of view, the reaction $\pi^- p \to \eta n$ is very interesting because, although two Regge trajectories A_2 and $\delta(970)$ are exchanged in this process, the A_2 trajectory, being higher, dominates at high energy. However, because of the difficulty in the detection of the neutral particles produced in the scattering, the experimental measurements are not very precise. Recently, the differential cross section $d\sigma/dt$ for this reaction has been measured by Dahl *et al.* (1976) and Shaevitz *et al.* (1976) up to 200 GeV. Navelet and Stevens (1976) have presented a parameterization of the A_2 s-channel flip and nonflip helicity amplitudes in terms of Regge poles and effective cuts, in order to obtain good agreement between theory and experiment. We will show in this note that even if the spin effect is neglected these recent high energy data can be explained on a simple Regge pole model by considering A_2 as the dominant trajectory and assigning a phenomenological value to the residue function.

The main characteristics of the high energy $\pi^- p \to \eta n$ angular distribution are:

(1) The differential cross section $d\sigma/dt$ has a pronounced dip in the forward direction.

(2) At a fixed energy the angular distribution is parabolic in the interval $0 \leqslant -t \leqslant 1 \cdot 2\,(\text{GeV}/c)^2$.

(3) The differential cross section decreases with increase in energy.

We will see that all these characteristics can be described by a simple Regge pole model. In addition, the energy dependence, being determined by the A_2 trajectory, will be used to obtain the equation of this trajectory.

According to the simple Regge pole model, if the spin effect is ignored, the scattering amplitude T for a reaction involving the exchange of a single Regge trajectory is given by

$$T = \gamma(t)\,\xi(t)\,s^{\alpha(t)},$$

where $\gamma(t)$ is the residue function, which is unknown theoretically, and $\xi(t)$ is the signature factor. Then the differential cross section may be written as

$$d\sigma/dt = \{|\beta(t)|^2/sp^2\}s^{2\alpha(t)}.$$

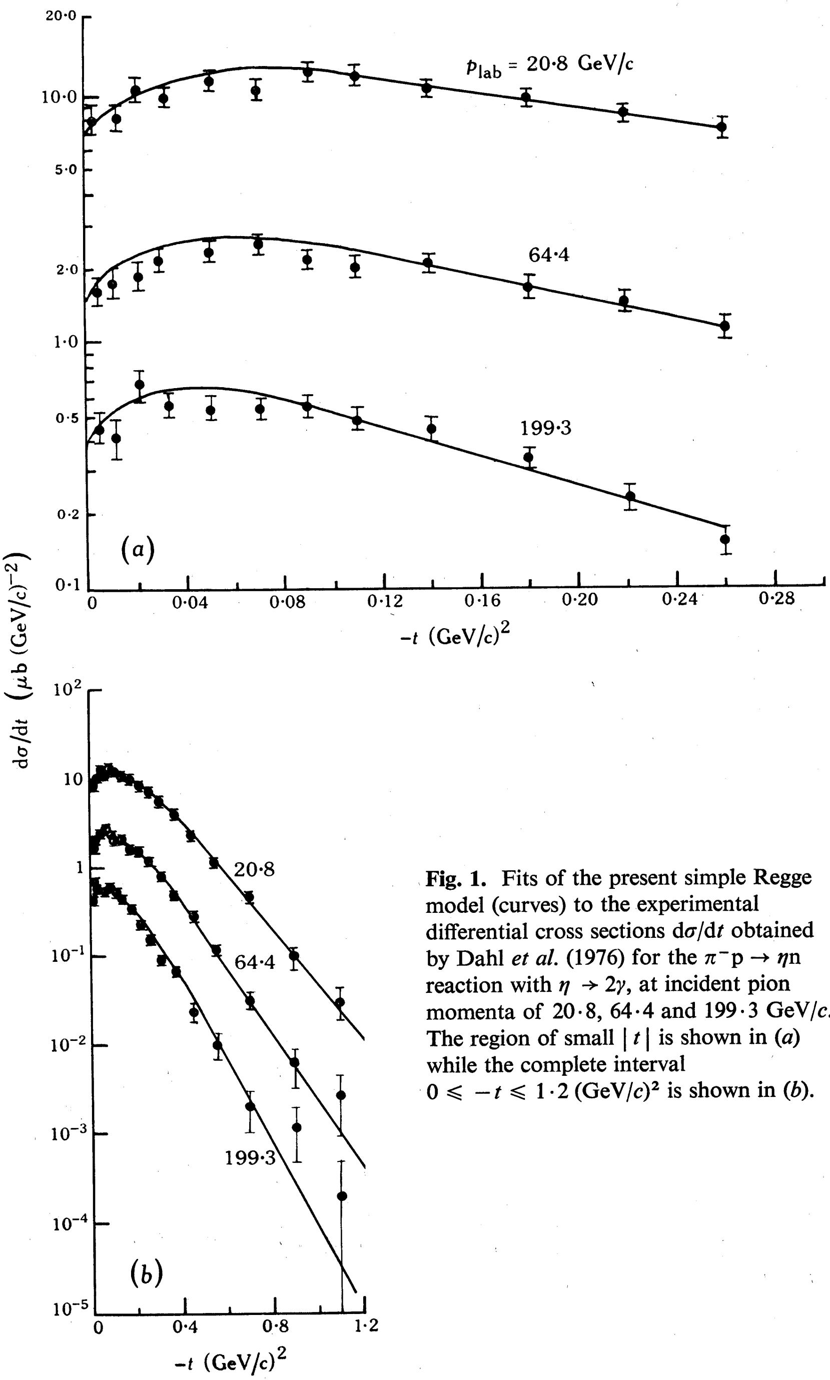

Fig. 1. Fits of the present simple Regge model (curves) to the experimental differential cross sections $d\sigma/dt$ obtained by Dahl *et al.* (1976) for the $\pi^-p \rightarrow \eta n$ reaction with $\eta \rightarrow 2\gamma$, at incident pion momenta of 20·8, 64·4 and 199·3 GeV/*c*. The region of small $|t|$ is shown in (*a*) while the complete interval $0 \leqslant -t \leqslant 1\cdot 2$ (GeV/*c*)^2 is shown in (*b*).

Here $\alpha(t)$ represents the A_2 trajectory, p is the c.m. momentum of the incident pion and $\beta(t) = \gamma(t)\xi(t)$.

Following Saleem *et al.* (1977), we assign a phenomenological value to the residue function by making use of the fact that the angular distribution curve is parabolic in the interval $0 \leqslant -t \leqslant 1\cdot 2\,(\mathrm{GeV}/c)^2$. We then find that in this four-momentum transfer interval a very good fit with experiment is obtained by taking

$$|\beta(t)| = 12\cdot 35\exp\{2\cdot 11\,t + 2\cdot 75\,|\sqrt{(-t)}|\},$$
$$\alpha(t) = 0\cdot 37 + 0\cdot 80\,t.$$

The branching ratio factor has been absorbed in the residue function.

The curves in Fig. 1 show the results of the fit of the present model to the experimental data of Dahl *et al.* (1976). Those authors tried to describe their data with a simple Regge pole model, but they used energy-dependent parameters and a nonlinear Regge trajectory. As can be seen from Fig. 1, however, by taking a different expression for the residue function we have been able to obtain a very good fit to the same data using energy-independent parameters and a linear trajectory. Our model thus satisfactorily describes the $\pi^- p \to \eta n$ differential cross section with a minimum of parameters.

Acknowledgment

Two of us (M.S. and M.R.) are grateful to the Pakistan Science Foundation for financial assistance.

References

Dahl, O. I., *et al.* (1976). *Phys. Rev. Lett.* **37**, 80.
Navelet, H., and Stevens, P. R. (1976). CEN Preprint No. DPH–T/76/105.
Saleem, M., Rafique, M., and Hussain, M. (1977). Punjab Univ. Rep. No. TH–7/77.
Shaevitz, M. H., *et al.* (1976). *Phys. Rev. Lett.* **36**, 5.

Manuscript received 28 February 1978