CC/NUMBER 7
FEBRUARY 17, 1986

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Hamilton J & Woolcock W S. Determination of pion-nucleon parameters and phase shifts by dispersion relations. *Rev. Mod. Phys.* 35:737-87, 1963.
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The paper describes the application of single-variable dispersion relations to the accurate numerical calculation of the main parameters of low-energy pion-nucleon scattering and the low-energy pion-nucleon phase shifts. The theoretical basis of the calculational methods is fully discussed. [The *SCI*® indicates that this paper has been cited in over 330 publications since 1963.]

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November 11, 1985

My part of the work reported in this paper was done during the years 1958-1961, while I was a postgraduate student in Jim Hamilton's research group. It was a lively group working on the use of dispersion relations to understand the dynamics of the pion-nucleon interaction. My work was mainly concerned with the use of the dispersion relations for the two invariant amplitudes at fixed momentum transfer in the neighbourhood of the forward direction.

The calculations began with the discovery that one could use an unsubtracted dispersion relation for one of the invariant amplitudes to obtain a precise value of the pion-nucleon coupling constant. The method worked because pion-nucleon scattering is dominated by resonances, most of which were by then well established. Once the coupling constant was precisely determined, it was possible to combine other experimental data with dispersion relation results to obtain reasonably accurate values of the s-wave and p-wave scattering lengths.

I then attempted to obtain the pion-nucleon s-wave, p-wave, and d-wave amplitudes up to moderate energies by inverting the expansions of the invariant amplitudes in terms of partial wave amplitudes and making a truncation. There were considerable uncertainties in the method, but, perhaps with some luck, I obtained values of the s-wave and p-wave phase shifts that agreed with values extracted from accurate experiments near 100 MeV. I then had reliable knowledge of the behaviour of the s-wave and p-wave amplitudes up to around 120 MeV, and this was used as input data to partial wave dispersion relations to obtain information about the pion-pion interaction.[1,2]

These calculations were written up in my doctoral thesis, but then, because my father was very ill, I returned to Brisbane and became immersed in the teaching of mathematics. Jim Hamilton decided to write a review that would contain an account of my calculations together with a full discussion of the dispersion relations on which they were based. He considered the high-energy behaviour of the scattering amplitudes and its consequences for the number of subtractions required in the dispersion relations. He also investigated the convergence problems associated with my method of obtaining the partial wave amplitudes and showed where the calculations could be trusted and where they became unreliable. The hard work of writing the review fell completely on Hamilton's shoulders.

The paper brought together in a comprehensive way the theoretical and practical aspects of fixed momentum transfer dispersion relations for the pion-nucleon system. It gave precise numerical values of the parameters and low-energy phase shifts, quantities that are needed for many other investigations. That is no doubt why the paper was so often cited. It was one of the forerunners of the regular compilations of coupling constants and low-energy parameters, of which the latest is that of Dumbrajs and colleagues.[3]

1. **Hamilton J, Spearman T D & Woolcock W S.** s-Wave pion-nucleon scattering and pion-pion interactions. *Ann. Phys. NY* 17:1-40, 1962.
2. **Hamilton J, Menotti P, Oades G C & Vick L L J.** Pion-nucleon scattering and pion-pion interactions. *Phys. Rev.* 128:1881-907, 1962. (Cited 135 times.)
3. **Dumbrajs O, Koch R, Pilkuhn H, Oades G C, Behrens H, de Swart J J & Kroll P.** Compilation of coupling constants and low-energy parameters. *Nucl. Phys. B* 216:277-335, 1983.

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