approximant. The methods differ in higher approximants. The Padé method is, however, much simpler since they must solve a nonlinear differential equation even in their second approximant. Also, their criterion for choosing a function to approximate is based on the smoothness of the function (thus they chose to use $\delta$ instead of $\tan\delta$). Our calculations are observed to converge more rapidly than do theirs.

The dispersion calculation which can be most easily compared with ours is that of Ref. 6. They calculated the left-hand cut in perturbation theory and then constructed the partial wave from the $N/D$ method. They had difficulty in achieving convergence for $|\lambda|>0.1$. Although their method works in potential scattering, we remark that in field theory there is no reason to expect the left-hand cut to converge as a function of $\lambda$. We believe that had the Padé method been used to rearrange the perturbation expansion of the left-hand cut, their convergence would have improved.

Although for $\lambda=0.115$ we get a $\rho$ resonance at the right position, its width is too small by a factor of 6. Also, for this value of $\lambda$, the $I=0$ $s$ wave shows no resonance-type structure. This value of $\lambda$ is, however, compatible with the $I=2$ data. A recent analysis[15] gave $|a_{02}|=0.204\pm0.028$. If we take the sign of $\delta_{02}$ from the analysis of the $\rho$-decay asymmetry parameter[12] and use Fig. 2, we get $\lambda=0.106\pm0.015$.

## IV. CONCLUSIONS

We have seen that the Padé approximant can be successfully applied in field theory to yield converging results where the perturbation expansion fails. It is our belief that low-order approximants provide a good approximation for intermediate-strength couplings where only a small number of resonances dominate.

The present calculation yields a $p$-wave resonance at 760 MeV for $\lambda=0.115$ with a width of 18 MeV. For this value of $\lambda$, the $s$ waves are small and negative. We do not, however, place much faith in the $p$-wave result since one must go to fourth order and the [2,2] Padé approximant in order to check convergence for the $p$ wave.[16] For the $s$ waves, convergence is already good. It will be interesting to see if the $\rho$ resonance persists in fourth order.

As is mentioned in Ref. 9, the field-theory case is complicated by the presence of extra singularities associated with the Dyson "collapsed state." These extra singularities have a branch point at $\lambda=0$ which makes the perturbation expansion asymptotic. It has been shown that the Padé method can also cope with these extra singularities.[17] However, since the coefficients in the asymptotic expansion are believed to grow like $n!$, these extra singularities will dominate in higher orders and may limit the usefulness of the Padé method. A deeper understanding of this difficulty is desirable.

*Note added in proof.* After completing this work a CERN report by Bessis and Pusterla[18] was received. They do a similar calculation but include fourth-order perturbation theory and analytically continue in $l$. The real part of the Regge trajectories for the $\rho$ and $f_0$ mesons are obtained correctly to within 15% for $\lambda\approx0.12$. We consider this to be very encouraging.

[15] T. S. Yoon, P. Berenyi, A. W. Key, J. D. Prentice, N. R. Steenberg, E. West, W. A. Cooper, W. Manner, L. Voyvodic, and W. D. Walker, Bull. Am. Phys. Soc. **12**, 684 (1967).

[16] Fourth-order calculations are being done by M. A. Newton (private communication).

[17] G. A. Baker, Jr., and R. Chisholm, J. Math. Phys. **7**, 1900 (1966).

[18] D. Bessis and M. Pusterla, Phys. Letters **25B**, 279 (1967).

# Errata

**Low-Energy Theorem for the Weak Axial-Vector Vertex,** S. L. ADLER AND Y. DOTHAN [Phys. Rev. **151**, 1267 (1966)]. In Eq. (80) for $M_{\lambda\alpha}{}^R$, the tensor multiplying $F_1{}^{V\prime}(0)$ should be $(q_\lambda\gamma_\alpha+k_\alpha\gamma_\lambda-\delta_{\lambda\alpha}\gamma\cdot k)$. In Eq. (82) for $O_{\lambda\alpha}$, the tensor multiplying $\bar{V}_2{}^{(0)}|_0$ should be $[(p_1+p_2)_\lambda k_\alpha-(p_1+p_2)\cdot k\delta_{\lambda\alpha}]$. Throughout Sec. III, $M^2{}_N$ should be read as $M_N{}^2$. We wish to thank Dr. J. Yellin for helpful discussions.

**Towers as Sets of Composite Particles and Trouble with Infinite-Component Field Theories,** M. B. HALPERN [Phys. Rev. **159**, 1328 (1967)]. Strictly speaking, our discussion is only valid when one has crossing symmetry in the usual sense; that is, towers must be viewed as sets of composite particles if crossing is to be maintained. We thank Dr. C. Fronsdal for emphasizing to us that, in his theory, the external particles are also part of an infinite- dimensional representation—thus the usual crossing is lost.