Kanesawa and Tomonaga, who first applied it to photon-scalar meson interaction[1] and then to the photon-vector meson system.[2] The invariant interaction Hamiltonian satisfies the condition of integrability (A):

$$[H_P[\sigma], H_{P'}[\sigma]]+\frac{h}{i}\left\{\frac{\delta H_{P'}[\sigma]}{\delta\sigma_P}-\frac{\delta H_P[\sigma]}{\delta\sigma_{P'}}\right\}=0, \quad (A)$$

where x'_P is space-like separated from x_P. In view of the probable lack of availability of the Prog. Theo. Phys. journal, we shall summarize the Kanesawa-Tomonaga procedure very briefly. One computes the total Hamiltonian, subtracts off the Hamiltonian without interaction, and obtains the interaction part of the Hamiltonian. One makes the contact transformation on this to the uncoupled field situation. The resulting Hamiltonian is usually not an invariant. In going to the Tomonaga relativistic wave equation, one adds on to this a part depending on the normal to the space-like surface which causes the Hamiltonian to satisfy condition (A) and also makes it an invariant. Thus, for the photon-vector meson-nucleon system we get the following:

$$H=H_{np}+H_{mp}+H_{1nm}+H_{2nm}+H_{1nmp}+H_{2nmp}+H_{1n}+H_{2n},$$

where

$$H_{np}=-i\epsilon\bar{\psi}\gamma^\mu\tau_P\psi A_\mu,$$

$$H_{mp}=i\epsilon/2(G_{\mu\nu}U_{\mu\nu}-U_{\mu\nu}G_{\mu\nu})-\tfrac{1}{2}(i\epsilon)^2(G_{\mu\nu}{}^*G_{\mu\nu}+2G_{\mu\nu}{}^*G_{\mu\sigma}N_\nu N_\sigma)-[(i\epsilon)^2/\mu^2]A_\mu A_\nu U_{\mu\lambda}U_{\nu\rho}{}^*N_\lambda N_\rho,$$

$$H_{1nm}=f_1J_\mu\phi_\mu+f_1{}^*J_\mu{}^*\phi_\mu{}^*,$$

$$H_{2nm}=(f_2/2)S_{\mu\nu}U_{\mu\nu}+(f_2{}^*/2)S_{\mu\nu}{}^*U_{\mu\nu}{}^*,$$

$$H_{1nmp}=(i\epsilon/\mu^2)f_1(A_\lambda U_{\lambda\mu}N_\mu)(J_\nu N_\nu)-(i\epsilon/\mu^2)f_1{}^*(A_\lambda U_{\lambda\mu}{}^*N_\mu)(J_\nu{}^*N_\nu),$$

$$H_{2nmp}=-(i\epsilon/2)f_2(S_{\mu\nu}G_{\mu\nu}+2S_{\mu\nu}G_{\mu\sigma}N_\nu N_\sigma)+(i\epsilon/2)f_2{}^*(S_{\mu\nu}{}^*G_{\mu\nu}{}^*+2S_{\mu\nu}{}^*G_{\mu\sigma}{}^*N_\nu N_\sigma),$$

$$H_{1n}=(f_1f_1{}^*/\mu^2)(J_\mu{}^*N_\mu)(J_\nu N_\nu),$$

$$H_{2n}=(f_2f_2{}^*/2)S_{\mu\nu}{}^*(S_{\mu\sigma}-S_{\sigma\mu})N_\nu N_\sigma,$$

and where we define

$$J_\mu\equiv\bar{\psi}\gamma^\mu\tau_{PN}\psi,$$

$$S_{\mu\nu}\equiv\bar{\psi}\gamma^{\mu\gamma\nu}\tau_{PN}\psi,$$

$$G_{\mu\nu}\equiv A_\mu\phi_\nu-A_\nu\phi_\mu,$$

$$U_{\mu\nu}\equiv\partial\phi_\nu/\partial x_\mu-\partial\phi_\mu/\partial x_\nu,$$

and where A_ν is the photon field; ϕ_ν the meson field; and ψ the nucleon field. The H_{nmp} terms constitute the new contributions in as much as H_{mp} was first obtained by Kanesawa and Tomonaga[2] while $H_{1nm}+H_{2nm}+H_{1n}+H_{2n}$ by Miyamoto[3] with the δ-type terms expressed differently. In deriving H we used the Proca formalism for the meson field. On the other hand, Miyamoto in considering the nucleon-meson interaction used in the Stuckleberg formulation[4] employing two auxiliary fields. Preliminary calculations revealed no simple way of including the photon interaction into the Stuckleberg procedure.[4]

For completeness' sake we give the photon-scalar meson-nucleon interaction Hamiltonian:

$$H=H_{np}+H_{mp}+H_{1nm}+H_{2nm}+H_{2nmp}+H_{2n},$$

where

$$H_{np}=-i\epsilon\bar{\psi}\gamma^\mu\tau_P\psi A_\mu;$$

$$H_{mp}=i\epsilon A_\mu\left(\phi^*\frac{\partial\phi}{\partial x_\mu}-\frac{\partial\phi^*}{\partial x_\mu}\phi\right)-(i\epsilon)^2(A_\mu{}^2-(A_\mu N_\mu)^2)\phi^*\phi,$$

$$H_{1nm}=f_1\bar{\psi}\tau_{PN}\psi\phi+f_1{}^*\bar{\psi}\tau_{NP}\psi\phi^*,$$

$$H_{2nm}=f_2\bar{\psi}\gamma^\mu\tau_{PN}\psi\frac{\partial\phi}{\partial x_\mu}+f_2{}^*\bar{\psi}\gamma^\mu\tau_{NP}\psi\frac{\partial\phi^*}{\partial x_\mu},$$

$$H_{2nmp}=-i\epsilon f_2\{\bar{\psi}\gamma^\mu\tau_{PN}\psi A_\mu\phi+\bar{\psi}\gamma^\mu\tau_{PN}\psi N_\mu A_\nu N^\nu\phi\}+i\epsilon f_2{}^*\{\bar{\psi}\gamma^\mu\tau_{NP}\psi A_\mu\phi^*+\bar{\psi}\gamma^\mu\tau_{NP}\psi N_\mu A_\lambda N_\lambda\phi^*\},$$

$$H_{2n}=f_2f_2{}^*(\bar{\psi}\gamma^\mu\tau_{NP}\psi)N_\mu(\bar{\psi}\gamma^\lambda\tau_{PN}\psi)N_\lambda.$$

H_{mp} is to be found in reference 1 and $H_{1nm}+H_{2nm}+H_{2n}$ in reference 3.

1 Kanesawa and Tomonaga, Prog. Theo. Phys. 3, 1 (1948).
2 Kanesawa and Tomonaga, Prog. Theo. Phys. 3, 101 (1948).
3 Miyamoto, Prog. Theo. Phys. 3, 124 (1948).
4 Stuckleberg, Helv. Phys. Acta. 11, 225, 299 (1938).
5 Another aspect which requires more investigation is the utilization of Kemmer's linear formulation. The problem here is the role of the auxiliary conditions.

Erratum and Addendum: Domain Interactions in the Theory of Ferromagnetic Resonance

[Phys. Rev. 75, 893 (1949)]

George T. Rado
Naval Research Laboratory, Washington, D. C.
March 22, 1949

BECAUSE of typographical errors, Eq. (2) of this Letter to the Editor appeared incorrectly. The correct equation is:

$$P=1+\frac{1}{2(r+1)}+\frac{1}{2(r+1)^2}\left[\frac{r+1}{r}\right]^{\frac{1}{2}}\tanh^{-1}\left[\frac{r}{r+1}\right]^{\frac{1}{2}}. \quad (2)$$

This change does not affect any of the calculations or statements of the previous letter (to be referred to as A).

It seems appropriate to emphasize at this time that (as noted in A) the use of Eq. (1) of A for the local field H' *assumes* the validity of a $1/H^2$ law for the approach to technical saturation. The proposed theory is, therefore, particularly applicable to pure nickel[1] carefully annealed in pure hydrogen and to alloys of high nickel content (e.g., Supermalloy). In the case of iron,[2] on the other hand, the law of approach in the fields of interest ($\approx 10^3$ oersteds) is often of the $1/H$ type; for this reason the resonance data for iron were not considered in A.

In a recent experiment Yager and Merritt[3] found that in the particular case of a certain Heusler alloy the Landé g-factor calculated from their microwave resonance data on the basis of Kittel's theory (i.e., by neglecting domain interactions) agrees essentially with Barnett's experimental g-value. This result may well be due to the failure of the $1/H^2$ law of approach to saturation. The details of this problem will be discussed at a later date.

Note Added in Proof: In paper *A* the author used and cited L. Néel's formula (J. de phys. et rad. [VIII] 9, 193 (1948)) for the approach to saturation. It has since come to his attention that this formula was also derived by T. Holstein and H. Primakoff, Phys. Rev. 59, 388 (1941), Eq. (25).

1 L. Néel, J. de phys. et rad. [VIII] 9, 193 (1948). In this paper Néel provides experimental confirmation (for nickel) for his $1/H^2$ law of approach to saturation.
2 L. Néel, J. de phys. et rad. [VIII] 9, 184 (1948). In this paper Néel provides experimental confirmation (for iron) for his $1/H$ law of approach to saturation.
3 W. A. Yager and F. R. Merritt, Phys. Rev. 75, 318 (1949). This paper appeared after paper A had been submitted for publication.

Cosmic-Ray Induced Nuclear Stars at High Altitudes*

P. Freier, E. P. Ney, and F. Oppenheimer
University of Minnesota, Minneapolis, Minnesota
March 23, 1949

WE have tabulated the rate of nuclear star formation in Ilford C2 emulsions sent aloft by General Mills balloons in Minnesota under various conditions. The results are summarized in Table I. We believe that the result will be