Minimal left-right symmetry model for electroweak interaction

Conference Paper · September 2007

1 author:

Asan Damanik
Universitas Sanata Dharma

Proceedings

2nd

JOGJA International Physics Conference

"Enhancing Network and Collaboration Developing Research and Education in Physics and Nuclear Energy"

Conference Hall
Faculty of Mathematics and Natural Science
September 6-8, 2007

Keynote Speakers

Ir. Sukarman Aminjoyo (BAPETEN, Indonesia)
Dr. Baek Jong-Bok (Korea Hidro and Nuclear Power Co.Ltd, South Korea)
Prof. Ren-Tai Chiang, Ph.D (University of Florida USA and GF Energy, USA)
Dr. Harini Sosiati (Kyushu University, Japan)
Prof. Dr. Muhamad Mat Salleh (University Kebangsaan Malaysia)
Dr. Yusril Yusuf (G.H. Brown award winner 2007, Gadjah Mada University)
Prof. Dr. Yoshitsugu Tomokiyo (Kyushu University, Japan)

Organized by:
Physics Department
University of Gadjah Mada
Yogyakarta Indonesia

ORGANIZING COMMITTEE

The Advisors board

- Prof. Ir. Y. Sardjono (P3TM-Indonesia)
- Prof. Dr. Shoichi Kai (Kyushu University-Japan)
- Prof. Dr. Muhamad Mat Salleh (Universiti Kebangsaan Malaysia)
- Prof. Suparwoto (UNY-Indonesia)
- Prof. Dr. Kusminarto (UGM-Indonesia)
- Dr. Kamsul Abraha (UGM-Indonesia)
- Dr. Jazi Eko Istianyanto (UGM-Indonesia)

The Technical Program Committee

- Chairperson :
  Dr. Sismanto

- Secretary :
  Dr. Mirza Satriawan
  Edi Hartantyo, M.Si

- Treasurer :
  Dra. Chotimah, M.S.
  Ilona Usuman, M.Kom

- Programs :
  Dr. Kuwat Triyana
  Dr. Yusril Yusuf
  Harsojo, M.Sc.
  Agus Supriyanto, M.Si (UNS)
  Ari Dwi Nugraheni, S.Si
  Ahmad Kusumaatmaja, S.Si

- Scientific Program :
  Dr. Karyono
  Dr. M.F. Rosyid
  Dr. Kamsul Abraha
  Dr. Ahmad Ashari

- Publication :
  Eko Sulistyo, M.Si
  Mitrayana, M.Si

- Documentation and Acomodation :
  Dr. Ari Setiawan
  R. Sumiharto, M.Kom
  M. Ikhsan, M.Si

- Exhibition:
  Fachrudin Nugroho, M.Si

Foreword

On behalf of the organizer of the 2nd Jogja International Physics Conference, I would like to give our sincere gratitude to all the participant of the conference. I would like to give our deepest appreciation and gratitude to all of keynote speakers of this conference, namely Ir. Sukarman Aminjoyo, APU (BAPETEN), Dr. Baek Jong-Bok (Korea Hidro and Nuclear Power Co. Ltd.), Prof. Ren-Tai Chiang (Univ. Of Florida and GE Energy USA), Prof. Dr. Muhammad Mat Salleh (Univ. Kebangsaan Malaysia), Prof. Yoshitsugo Tomokiyo (Kyushu Univ. Japan), Dr. Harini Sosiati (Kyushu Univ. Japan), Dr. Yoshiki Hidaka (Kyushu Univ. Japan), Dr. Yusril Yusuf (Gadjah Mada Univ.).

The second Jogja International Physics Conference is the second conference organized by the Physics Department Gadjah Mada University continuing, previously was called, the 1st Jogja Regional Physics Confêrence 2004. This conference is aimed for promoting, developing, and disseminating interdisciplinary research from many different fields of physics, for the betterment of human lives. The conference was intended as a forum for the physicist from different branches of physics, and different countries, especially from the Asian and surrounding region, to meet and discuss, developing research and collaboration. It is also intended as a forum for dissemination of the latest research results from many different fields of physics. As Indonesia is currently planning developing its first power plant nuclear reactor, we also hope to enhance understanding of the current result in the nuclear reactor theory and technology. The theme of the conference is *Enhancing Network and Collaboration – Developing Research and Education in Physics and Nuclear Energy*. The topics covered in this conference are from very broad spectrum of Physics, such as Nuclear Energy, Atomic Physics, Theoretical and Mathematical Physics, Computational Physics, Nanotechnology, Material Science, Geophysics, Electronics Instrumentation, Bio and Medical Physics, and Educational Physics.

In this conference there are 8 papers in the panel session, presented by eigth invited speaker in two days. For the parallel session there are 63 papers to be presented in the conference. The presented papers consist of Nuclear Energy and Atomic Physics 8 papers, Theoretical and Mathematical Physics 8 papers Computational Physics 9 papers, Nanotechnology 5 papers, Material Science 6 papers, Geophysics 10 papers, Electronics and Instrumentation 17 papers.

The committees have worked in arranging the program for the benefit of the paticipants. The committee hopes that this conference could enrich, enhance the physics knowlegde, and served as a forum for individuals to meet and discuss the physics current issues. We sincerely appreciate the support and encouragement from Physics Department of Gadja Mada University, BAPETEN, Atomic and Nuclear laboratory, Electronics Instrumentations Laboratory, Geophysics laboratory, Solid state laboratory, Basics Physics Laboratory, Graduate School (Pascasarjana) in University of Gadjah Mada, and D3 Study Program. Last but not least I would also give my thanks to the student volunteers in Physics Departement.

With sincere gratitude

Chairman of the 2nd JIPC 2007

Dr. Sismanto

Foreword

Distinguished guests
Honorary speakers
Ladies and gentlemen
Welcome to the 2nd Jogja International Physics Conference.
We gather here today to communicate our scientific activities, to learn from each other, to find an opportunity to collaborate with each other, and to share our experience.

The world-wide web has become our closest friend. No day passes without us accessing the Internet. It was Tim Berners-Lee, a physicist, who initiated the Internet lifestyle. When Berners-Lee dreamed about creating a tool to enable reseachers all over the world to collaborate, only one word was in his mid: share it, share it, share it.

We do not lose anything when we share. In fact, we enrich our knowledge.

Now, we share our experiences to improve our knowledge, to

Physicists have been known to initiate new things. And it will stay that way. Physicists should cultivate freedom. Freedom to think, freedom to try lots of things, freedom to explore opportunities from philosophy to engineering.

It was a physicist who initiate the industrial revolution. It was a physicist who initiate the information revolution.

We hope you have a pleasant stay in Jogjakarta.
FYI, the physics department at gadjah mada university was founded in 1955. Now, we have three B.Sc programs : physics, geophyics, and electronics & instrumentation, a 3-year diploma program in Electronics & Instrumentation, an M.Sc and a Ph.D in Physics.

With sincere gratitude

Head of Physics Department

J.E. Istiyanto

Dr. Jazi Eko Istiyanto

CONTENTS

THEORETICAL AND MATHEMATICAL PHYSICS

COMPUTATIONAL PHYSICS

NANOTECHNOLOGY

MATERIAL SCIENCES

GEOPHYSICS

ELECTRONICS AND INSTRUMENTATION

Minimal Left-Right Symmetry Model for Electroweak Interaction

Asan Damanik[1,2,*], Mirza Satriawan[2], Pramudita Anggraita[3], Arief Hermanto[2]
[1]*Department of Physics, Sanata Dharma University,*
Kampus III USD Paingan, Maguwoharjo, Sleman, Yogyakarta, Indonesia
[2]*Department of Physics, Faculty of Mathematics and Natural Sciences,*
Gadjah Mada University, Yogyakarta, Indonesia
[3]*National Nuclear Energy Agency (BATAN), Jakarta, Indonesia*

Abstract

Following the procedure in the Glashow-Weinberg-Salam (GWS) model for electroweak interaction, by using two doublets and one induced bidoublet Higgs fields as a result of the interactions of the two doublets, we evaluate the predictive power of the left-right symmetry model based on $SU(2)_L \times SU(2)_R \times U(1)$ gauge group to the gauge bosons masses, leptons masses, and the structure of electroweak interactions. Both bidoublet and doublet Higgs fields have the contribution to the gauge bosons masses after symmetry breaking. Meanwhile, leptons masses arise only from the bidoublet Higgs field. The parity violation could be associated with the mixing of the charged gauge bosons masses from the induced bidoublet Higgs.

Keywords: *left-right symmetry model, electroweak interaction, doublet and bidoublet.*

*Corresponding author
E-mail: d.asan@lycos.com

I. Introduction

Even though the Glashow-Weinberg-Salam (GWS) model for electroweak interaction based on $SU(2)_L \times U(1)_Y$ gauge group very successful phenomenologically [1-3], but many fundamental problems i.e. the responsible mechanism for generating the neutrino masses, the domination of the V-A over V+A interactions at low energy, and the responsible mechanism for the doublet lepton up-down mass difference could not be explained by GWS model. The need for the extension of the GWS model comes from the conclusion that neutrinos have a mass as an implication of the detected neutrino oscillations phenomena for both solar and atmospheric neutrinos [4-10].

Many theories or models for extension of the GWS model have been proposed. One of the interesting models is the Left-Right symmetry model based on $SU(2)_L \times SU(2)_R \times U(1)$ gauge group proposed by many authors [11-15]. In this paper, we use the left-right symmetry model based on $SU(2)_L \times SU(2)_R \times U(1)$ gauge group with two doublets and one bidoublet Higgs fields (as a result of the two doublets interaction) to break the $SU(2)_L \times SU(2)_R \times U(1)$ gauge group down to $U(1)_{em}$. The lepton fields to be represented as doublet of an SU(2) for both left and right fields to make the full sense of the left-right symmetry model.

The paper is organized as follows: in section II we present our main assumptions for the left-right symmetry model, in section III we evaluate the gauge bosons masses, in section IV we evaluate the leptons masses, and finally in section V we give a conclusion.

II. The Model

In our model, the left-right symmetry model for electroweak interaction based on the $SU(2)_L \times SU(2)_R \times U(1)$ gauge group with the assumptions and the particles assignment as follows:

1. Two primary Higgs fields are doublet of SU(2):

$$X_L = \begin{pmatrix} a^+ \\ b^0 \end{pmatrix}, \quad X_R = \begin{pmatrix} c^- \\ d^0 \end{pmatrix} \qquad (1)$$

2. The secondary bidoublet Higgs field ϕ could be produced from the interaction of the two primary Higgs fields, that is:

$$\phi = \begin{pmatrix} a^+c^- & a^+d^0 \\ b^0c^- & b^0d^0 \end{pmatrix} = \begin{pmatrix} p^0 & q^+ \\ r^- & s^0 \end{pmatrix} \qquad (2)$$

3. The leptons fields are doublet of SU(2) for both left and right fields:

$$\psi_L = \begin{pmatrix} \nu \\ e^- \end{pmatrix}_L, \quad \psi_R = \begin{pmatrix} \nu \\ e^- \end{pmatrix}_R. \qquad (3)$$

4. Both leptons and gauge bosons masses are generated via symmetry breaking

when Higgs fields develop its vacuum expectation values similar to the symmetry breaking in the GWS model.

By applying the above assumptions and particles assignment, we could break the left-right symmetry model based on $SU(2)_L \times SU(2)_R \times U(1)$ down to $U(1)_{em}$ directly as shown schematically below:

$$SU(2)_L \times SU(2)_R \times U(1)$$

$$\left.\begin{array}{l}\langle x_L\rangle \neq 0\\ \langle x_R\rangle \neq 0\end{array}\right\downarrow \quad \langle\phi\rangle \neq 0$$

$$U(1)_{em}$$

The vacuum expectation values of two doublets and one bidoublet Higgs could contribute to the gauge bosons masses. Meanwhile, the leptons masses (in Yukawa term) only emerge from the vacuum expectation value of bidoublet Higgs, because the leptons fields ψ_L and ψ_R to be doublet of SU(2), then only the Yukawa term with bidoublet Higgs satisfies gauge invariance. Thus, the complete Lagrangian density could be reads:

$$\begin{aligned}L = &-\tfrac{1}{4}W_{\mu\nu L}W^{\mu\nu L} - \tfrac{1}{4}W_{\mu\nu R}W^{\mu\nu R} - \tfrac{1}{4}B_{\mu\nu}B^{\mu\nu}\\ &+\bar{\psi}_L\gamma^\mu\left(i\partial_\mu - \tfrac{g}{2}\tau.W_{\mu L} - \tfrac{g'}{2}YB_\mu\right)\psi_L\\ &+\bar{\psi}_R\gamma^\mu\left(i\partial_\mu - \tfrac{g}{2}\tau.W_{\mu R} - \tfrac{g'}{2}YB_\mu\right)\psi_R\\ &+\left|\left(i\partial_\mu - \tfrac{g}{2}\tau.W_{\mu L} - \tfrac{g'}{2}YB_\mu\right)X_L\right|^2\\ &+\left|\left(i\partial_\mu - \tfrac{g}{2}\tau.W_{\mu L} - \tfrac{g'}{2}YB_\mu\right)X_R\right|^2\\ &+Tr\left|\left(i\partial_\mu - \tfrac{g}{2}\tau.W_{\mu L} - \tfrac{g'}{2}YB_\mu\right)\phi\right|^2\\ &+Tr\left|\left(i\partial_\mu - \tfrac{g}{2}\tau.W_{\mu L} - \tfrac{g'}{2}YB_\mu\right)\phi\right|^2\\ &-V(X_L, X_R, \phi) - \left(G\bar{\psi}_L\phi\psi_R + h.c\right)\end{aligned} \quad (4)$$

where $g_L = g_R = g$ are the SU(2) couplings, g' is the U(1) coupling, $\gamma^\mu(\mu = 0,1,2,3)$ are the Dirac matrices, τ's are the Pauli spin matrices, $V(X_L, X_R, \phi)$ is the Higgs potential, Y is the hypercharge ($Y = B - L$), and G is the Yukawa coupling.

The electric charge operator Q satisfies the relations:

$$Q = T_{3L} + T_{3R} + \frac{Y}{2} \quad (5)$$

where T_{3L} and T_{3L} are the third components the weak isospin generator: $T_i = \tau_i/2$.

According to the Eqs. (4) and (5), the Higgs fields have the following quantum numbers:

$$X_L\left(\tfrac{1}{2},0,1\right), X_R\left(0,\tfrac{1}{2},1\right), \phi\left(\tfrac{1}{2},\tfrac{1}{2},0\right) \quad (6)$$

and the leptons fields transform as:

$$\psi_L(2,0,0), \quad \psi_R(0,2,0) \quad (7)$$

III. The Gauge Bosons Masses

From Eq. (4), we can see that the relevant gauge boson mass terms as follow:

$$\begin{aligned}L_{boson} = &\left|\left(-\tfrac{g}{2}\tau.W_{\mu L} - \tfrac{g'}{2}YB_\mu\right)X_L\right|^2\\ &+\left|\left(-\tfrac{g}{2}\tau.W_{\mu L} - \tfrac{g'}{2}YB_\mu\right)X_R\right|^2\\ &+Tr\left|\left(-\tfrac{g}{2}\tau.W_{\mu L} - \tfrac{g'}{2}YB_\mu\right)\phi\right|^2\\ &+Tr\left|\left(-\tfrac{g}{2}\tau.W_{\mu L} - \tfrac{g'}{2}YB_\mu\right)\phi\right|^2\end{aligned} \quad (8)$$

By substituting the vacuum expectation values of the Higgs fields:

$$\langle x_L\rangle = \begin{pmatrix}0\\ b\end{pmatrix}, \langle x_R\rangle = \begin{pmatrix}0\\ d\end{pmatrix}, \langle\phi\rangle = \begin{pmatrix}p & 0\\ 0 & s\end{pmatrix}$$

into Eq. (8), we obtain:

$$\begin{aligned}L_{boson} = \tfrac{1}{4}\Big[&g^2b^2\left\{\left(W_{\mu L}^1\right)^2 + \left(W_{\mu L}^2\right)^2\right\} + b^2\left(gW_{\mu L}^3 - g'B_\mu\right)^2\\ &+g^2d^2\left\{\left(W_{\mu R}^1\right)^2 + \left(W_{\mu R}^2\right)^2\right\} + d^2\left(gW_{\mu R}^3 - g'B_\mu\right)^2\\ &+g^2\left(p^2+s^2\right)\left\{\left(W_{\mu L}^1\right)^2 + \left(W_{\mu L}^2\right)^2 + \left(W_{\mu L}^3\right)^2\right\}\\ &+g^2\left(p^2+s^2\right)\left\{\left(W_{\mu R}^1\right)^2 + \left(W_{\mu R}^2\right)^2 + \left(W_{\mu R}^3\right)^2\right\}\Big]\end{aligned} \quad (9)$$

By defining:

$$\begin{aligned}&W_L^\pm = \tfrac{1}{\sqrt{2}}\left(W_{\mu L}^1 \mp iW_{\mu L}^2\right), W_R^\pm = \tfrac{1}{\sqrt{2}}\left(W_{\mu R}^1 \mp iW_{\mu R}^2\right)\\ &Z_{\mu L} = \frac{gW_{\mu L}^3 - g'B_{\mu L}}{\sqrt{g^2+g'^2}}, Z_{\mu R} = \frac{gW_{\mu R}^3 - g'B_{\mu R}}{\sqrt{g^2+g'^2}},\\ &A_{\mu L} = \frac{g'W_{\mu L}^3 + gB_{\mu L}}{\sqrt{g^2+g'^2}}, A_{\mu R} = \frac{g'W_{\mu R}^3 + gB_{\mu R}}{\sqrt{g^2+g'^2}},\\ &Z'_{\mu L} = W_{\mu L}^3, \quad Z'_{\mu R} = W_{\mu R}^3,\\ &m_{W_L} = \frac{gb}{2}, \quad m_{W_R} = \frac{gd}{2}, \quad m_A = 0,\\ &m_{Z_L} = \tfrac{1}{2}b\sqrt{g^2+g'^2}, m_{Z_R} = \tfrac{1}{2}d\sqrt{g^2+g'^2},\\ &m_{W_L}^* = m_{W_R}^* = m_{Z'_L} = m_{Z'_R} = \tfrac{1}{2}g\sqrt{p^2+s^2},\end{aligned} \quad (10)$$

then Eq.(9) reads:

$$\begin{aligned} L_{boson} &= m_{W_L}^2 W_L^+ W_L^- + m_{W_R}^2 W_R^+ W_R^- \\ &+ m_{W_L}^{*2} W_L^+ W_L^- + m_{W_R}^{*2} W_R^+ W_R^- \\ &+ m_{Z_L}^2 Z_{\mu L} Z_L^\mu + m_{Z_R}^2 Z_{\mu R} Z_R^\mu \\ &+ m_A^2 A_\mu A^\mu + m_{Z'_R}^2 Z'_{\mu R} Z_R'^\mu \\ &+ m_{Z'_L}^2 Z'_{\mu L} Z_L'^\mu \end{aligned} \quad (11)$$

or

$$\begin{aligned} L_{boson} &= \left(m_{W_L}^2 + m_{W_L}^{*2}\right) W_L^+ W_L^- \\ &+ \left(m_{W_R}^2 + m_{W_R}^{*2}\right) W_R^+ W_R^- \\ &+ m_{Z_L}^2 Z_{\mu L} Z_L^\mu + m_{Z_R}^2 Z_{\mu R} Z_R^\mu \\ &+ m_A^2 A_\mu A^\mu + m_{Z'_R}^2 Z'_{\mu R} Z_R'^\mu \\ &+ m_{Z'_L}^2 Z'_{\mu L} Z_L'^\mu \end{aligned} \quad (12)$$

From Eq. (10), by following the standard model of electroweak interaction symmetry breaking procedure to the left-right symmetry model and put the value of $b = d$, we can see that the resulted gauge bosons masses for both left and right bosons are equal. To make the left-right symmetry model relevant to the electroweak phenomena, many authors [14,15,16] have taken the value of $b << d$. The difference values of the b and d can be associated with the parity violation.

The gauge bosons masses problem in our model, especially for charged bosons masses arise from bidoublet Higgs vacuum expectation values, could be resolved by defining:

$$\begin{pmatrix} \dot{m}_{W_L} \\ \dot{m}_{W_R} \end{pmatrix} = \begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix} \begin{pmatrix} m_{W_L}(\phi) \\ m_{W_R}(\phi) \end{pmatrix} \quad (13)$$

where the angle θ associated with parity violation, $m_{W_L}(\phi)$ and $m_{W_L}(\phi)$ are masses of the left and right W bosons from bidoublet Higgs fields. From Eq. (13) we can see that the maximal parity violation occur for $\theta = 45^0$ such that the total charged right bosons masses m_{W_R} very large compared to the left bosons masses m_{W_L}. For example, if we take values of the W_L and W_R bosons masses from doublet are $m_{W_L} = m_{W_R} = 82\,\text{GeV}$, then the reasonable values for gauge bosons W from induced bidoublet are $m_{W_L}(\phi) = m_{W_R}(\phi) = 6724$ GeV or $m_{W_L}(\phi) = m_{W_R}(\phi) \approx 7\,\text{TeV}$. If we take $\theta = 45^o$, then the right charge-current contribution (V+A interaction) to the electroweak interaction is only around 0.015 %. In this scheme, the domination of the V-A interaction over V+A interaction for charged current at low energy could be understood as an implication of the very massiveness of the m_{W_R} compared to m_{W_L}. The gauge bosons masses m_{W_L} in the maximal parity violation, only come from the doublet Higgs field X_L as formulated in the GWS model and supported by experimental fact that the boson masses emerge from doublet Higgs field.

IV. The Leptons masses

The leptons masses in our model arise from the symmetry breaking. The lepton mass term is the Yukawa term in Eq. (4), that is:

$$L_l = G\overline{\psi}_L \langle\phi\rangle \psi_R \quad (14)$$

By inserting the vacuum expectation value of bidoublet Higgs, then we obtain the masses: $m_\nu = Gp$ and $m_e = Gs$ for neutrino and electron respectively. In our minimal left-right symmetry model based on $SU(2)_L \times SU(2)_R \times U(1)$ gauge group the leptons masses (neutrino and electron) arise only from the bidoublet Higgs vacuum expectation values.

As long as we know, for leptons masses there is no experimental fact that force us to choose a one kind of multiplet Higgs in the Yukawa term except dictated by the requirement of the Lagrangian density must be gauge invariance. But, in the boson mass sector, the representation of the Higgs fields to be SU(2) doublet theoretically supported by experimental fact. Thus, we could use the induced bidoublet Higgs field as the responsible field for generating the leptons masses.

V. Conclusion

By using the minimal content of the particles (two primary doublets Higgs, one induced bidoublet Higgs (secondary Higgs), and two lepton fields) involve in the left-right symmetry model based on $SU(2)_L \times SU(2)_R \times U(1)$ gauge group, the domination of the V-A interaction over V+A interaction at low energy, the neutrino mass and the electron mass arise naturally. The parity violation in our model related to the mixing of the bosons masses arise from the induced bidoublet Higgs.

VI. References

1. P. D. B. Collins, A. D. Martin, and E. J. Squires, *Particle Physics and*

Cosmology, John Wiley & Sons, New York, 1989.
2. F. Gross, *relativistic Quantum Mechanics and Field Theory*, John Wiley & Sons, New York, 1993.
3. M. Fukugita and T. Yanagida, *Physics of Neutrinos and Application to Astrophysics*, Springer-Verlag, Berlin, 2003.
4. Y. Fukuda *et al., Phys. Rev. Lett.* **81,** 1158 (1998).
5. Y. Fukuda *et al., Phys. Rev. Lett.* **82,** 2430 (1999).
6. Y. Fukuda *et al., Phys. Rev. Lett.* **86,** 5656 (2001).
7. T. Toshito *et al.*, arXiv: hep-ex/0105023.
8. G. Giacomelli and M. Giorgini, arXiv: hep-ex/0110021.
9. Q. R. Ahmad *et al., Phys. Rev. Lett.* **89,** 011301 (2002).
10. M. H. Ahn *et al., Phys. Rev. Lett.* **90,** 041801-1 (2003).
11. J. C. Pati and A. Salam, *Phys. Rev.* **D10,** 275 (1975).
12. R. N. Mohapatra and J. C. Pati, *Phys. Rev.* **D11,** 566 (1975).
13. G. Senjanovic and R. N. Mohapatra, *Phys. Rev.* **D12(5),** 1502 (1975).
14. R. N. Mohapatra, F. E. Paige, and D. P. Sidhu, *Phys. Rev.* **D17(9),** 2462 (1975).
15. R. N. Mohapatra and G. Senjanovic, *Phys. Rev.* **D23,** 165 (1981).
16. G. Senjanovic, *Nucl. Phys.* **B153,** 334 (1979).