Proceedings of the

1976 DUMAND Summer Workshop

University of Hawaii Honolulu, Hawaii September 6–19, 1976

> Arthur Roberts Editor

Rene Donaldson Technical Editor



It is also a special pleasure to acknowledge the contributions to the conference of Mrs. Caroline Chong, secretary to the High Energy Physics group in the Physics Department of the University of Hawaii. Before, during, and after the conference, the organization of details of invitations, bulletins, reservations, tickets, all were in her capable hands. The conferees were unanimous in praising the smoothness and apparent ease with which all difficulties were solved and all special requests handled; and not least of all, the delicious "pupus" or Hawaiian snacks with which our coffee breaks were enlivened.

And finally, the efforts of Conference Secretary Marilyn Cowan-fortuitously bearing a name hallowed in neutrino history--made a special
place for her own, by the flexibility and skill with which she satisfied the
unpredictable and rapidly changing needs of the conferees for conference
space, projectors, recording equipment, instantaneous xeroxing and the
other perquisites of so loosely structured a meeting, and the dedication
with which she and her co-workers worked many long hours to assure the
smooth functioning of the Workshop.

TABLE OF CONTENTS

I. Review of Earlier Work

Page

Note on DUMAND at Catholic University and NSWC G. K. Riel	. 1
Current Status of DUMAND Projects	. 5
Introductory Talk on UNDINE	.15
DUMAND - UNICORN	. 21
II. Theory	
Weak Interactions with Large Dimensionless Constant ("Neutral Currents" as a Second Order Processes?)	. 35
Neutral Currents and Astrophysical Neutrinos	. 45
I. Time Correlations Between Neutrino and Photon Emission II. Flux Correlations in Low- and High-Energy Neutrino Emission R. Silberberg	. 55
III. UNDINE	
A. Sources	
Neutrinos From Gravitational Collapse	. 87
Diffusion Approximation to Neutrino Fluxes Out of Collapsing Stars . S. A. Bludman	115
Galactic and Extragalactic Supernova Frequencies	137
Group Report on Sources of Low Energy Neutrinos	163
B. Experimental Design	
Low Light Level Detectors for UNDINE	185
Adapting Counting Procedures to Bioluminescent Interference R. Davisson	207

IV. ATHENE and UNICORN	_
A. Sources	Page
"DUMAND" as a Neutrino Eye Watching Violent Remote Cosmological Epochs	. 215
Ultra High Energy Neutrinos and Detection Possibilities by DUMAND V. S. Berezinsky	. 229
B. Experimental Design	
Some Remarks on ATHENE	. 257
The Study of Ultra High Energy Neutrino Physics Using DUMAND D. Cline	. 265
Signatures of High Energy Neutrino Interactions and Their Detection Via Cerenkov Light	. 297
Cerenkov Detection Techniques	. 329
Angular Distributions and Fluxes of Throughgoing and Stopping Muons in Deep Underground Environments W. Frati, E. Freidlander, K. Lande, E. Fenyves, C. K. Lee, and O. Saavedra	. 351
Correlating Atmospheric Muons and Neutrinos	.365
Giant Air Showers ($E_p \approx 10^{18} 10^{19} \text{ eV}$) That Reach the DUMAND Array	. 371
V. Technology	
A. Oceanography, Siting	
Perspectives in Deep Oceanography	. 375
Ocean Technology Brief	.405
Ocean Engineering of the DUMAND Experiment	. 421
Bioluminescence and the DUMAND Experiment	. 453

and the state of t	Page
Planning and Status of the DUMAND/RUWS Undersea Site-Test Measurements	471
Preliminary Selection of a Site for DUMAND	487
Projected Optical and Particle Properties at the DUMAND-Maui Site	. 507
B. Acoustic Detection	
Generation of Acoustic Signal by Neutrino Interaction in Elastic Medium	. 517
Sonic Particle Detection	. 523
Acoustic Detection Techniques	. 53 1
Proposal to Test Feasibility of Acoustic Detection of Particle Showers DUMAND Ad hoc Experimental Acoustics Group L. R. Sulak, Spokesman	. 547
Studies of the Experimental Feasibility of Acoustic Detection of Particle Showers: A Progress Report DUMAND Ad hoc Experimental Acoustics Group L. R. Sulak, Spokesman	. 559
C. Cerenkov Detection	
Cherenkov Radiation from Showers Developing in Saline Water A. A. Belyaev, I. P. Ivanenko, and V. V. Makarov	. 563
Some Characteristics of Hadronic Cascades in Sea Water W. V. Jones	. 591
D. Data Processing	
Thoughts about Accuracy of Measurements	. 603
Data Processing in DUMAND	. 613
R. Davisson	. 623
Appendix 1 List of Participants DUMAND 1976 Summer Workshop	. 631
Appendix 2	. 633