

Atmospheric Halos and the Search for Angle x



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Walter Tape and Jarmo Moilanen

 American Geophysical Union
Washington, DC

Published under the aegis of the AGU Books Board

Jean-Louis Bougeret, Chair; Gray E. Bebout, Carl T. Friedrichs, Cassandra G. Fesen, Ralf R. Haese, W. Berry Lyons, Kenneth R. Minschwaner, Andy Nyblade, Darrell Strobel, and Chunzai Wang, members.

Library of Congress Cataloging-in-Publication Data

Tape, Walter.

Atmospheric halos and the search for angle X / Walter Tape and Jarmo Moilanen.

p. cm.

Includes bibliographical references and index.

ISBN-13: 978-0-87590-727-7

ISBN-10: 0-87590-727-X

1. Halos (Meteorology) 2. X-ray crystallography. I. Moilanen, Jarmo. II. Title.

QC976.H15T363 2006

551.56'7--dc22

2005030387

ISBN 10: 0-87590-727-X

ISBN 13: 978-0-87590-727-7

Book doi:10.1029/058SP

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2000 Florida Avenue, NW

Washington, DC 20009

Front cover: Halo display with 18°, 23°, and 35° circular halos. Fairbanks, Alaska, January 31, 2005.

Frontispiece: Lunar halo display with 9° and 22° circular halos, 22° and 46° column arcs, and 9°, 22°, and 24° plate arcs. Georg von Neumayer Station, Antarctica, July 11, 1987. Photo © Klaus Sturm.

Back cover: Halo display with M-arc. Viitasaari, Finland, January 8, 1999. Photo © Rainer Vilkkilä.

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978-0-87590-727-7/05/\$1.50+0.35.

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Book design by Dixon J. Jones

Cover design by Stuart Greenwell

Printed in the United States of America

Contents

	<i>Preface</i>	<i>vii</i>
1	Introduction	1
2	Ice Crystal Gallery	9
3	The Beginnings of Halo Science	21
4	How Halos Form	33
5	Halo Simulations	43
6	Halos From Prismatic Crystals	51
7	Odd Radius Halos Are Real	65
8	Odd Radius Circular Halos	71
9	Some Crystallography	91
10	Pyramidal Ice Crystals	101
11	The Search For Angle x	113
12	Refraction Halos and Wedge Angle	129
13	The Spin Vector	133
14	A User's Guide To Halo Poles	137
15	Odd Radius Plate Arcs	145
16	Odd Radius Column Arcs	165
17	Odd Radius Parry Arcs	179
18	Other Wedge Angles?	183
	<i>Appendix A: Pattern for Crystal Model</i>	<i>195</i>
	<i>Appendix B: Halo Terminology</i>	<i>197</i>
	<i>Appendix C: Halo Observation and Photography</i>	<i>199</i>
	<i>Appendix D: From Pixels to Degrees</i>	<i>203</i>
	<i>Appendix E: More Crystallography</i>	<i>211</i>
	<i>Appendix F: Living on the (w)Edge</i>	<i>219</i>
	<i>Bibliography</i>	<i>227</i>
	<i>Index</i>	<i>233</i>

Preface

What does an ice crystal look like? You would think that we would know by now. We do indeed know quite a bit about ice crystals, yet there is one intriguing variety that has remained obscure until recently. On occasion crystals of this sort occur in the atmosphere by the billions, so in one sense they are not at all uncommon or exotic. Moreover, they leave a characteristic signature in the sky, and their existence had therefore been conjectured, even in the nineteenth century. Nevertheless, for a long time nobody knew for sure what the crystals looked like. The crystals were seen for the first time only a few decades ago, and they have been seen well only recently. The shape of these crystals is determined by the so-called angle x . The search for angle x is the effort to discover what the crystals look like.

These crystals would not be so intriguing were it not for their signature in the sky. By signature we mean atmospheric halos, something akin to the familiar ring around the moon. But the halos associated with these special crystals are easily recognizable as being different—especially in size—from the ring around the moon; they are “odd radius” halos. For a long time the existence and nature of odd radius halos was as murky as that of the crystals that make them. We now think that we are beginning to understand them, but much remains to be done.

Some of what remains to be done is just a fleshing out of the photographic record of these halos. Here anyone can make a contribution, anyone who has modest camera equipment and is alert for what to watch for. We have no doubt that with increased awareness new halos will be seen and photographed, and we hope that some of you will be the ones to do so.

The ultimate goal of this book is to tell what is known about odd radius halos. But as you read on, you will see that the odd radius halos are partly just an excuse for us to talk about halos in general. One can even argue that it is the odd radius halos that *are* the “halos in general,” because it turns out that it is the odd radius halos that are in a sense typical, and it is the more traditional and more common halos that are exceptional—exceptional in the sense that they have special properties. The general context demanded by odd radius halos is the best setting for thinking about even the common halos.

The study of odd radius halos is very much a work in progress. There are still halo displays that we do not understand very well, and there are halo displays that we do not understand at all. Only recently have we begun to make the accurate measurements of halo radii that are necessary for testing the theory. And only recently have we begun to get electron microscope photographs of the ice crystals that may hold some of the secrets of odd radius halos.

In writing this book, we have tried to present things in such a way that you, the reader, can come to understand how we know what we know. The theory of halos is simple enough so that this can be done, at least to a large extent. So you should not have to take a lot on faith; we have tried to present enough of the reasoning so that you can largely judge the logic of the theory for yourself, and we have presented enough of the data—mainly halo and ice crystal photographs—so that you can test the predictions of the theory yourself. We have omitted some topics that we thought were speculative or whose conclusions were hard to justify in a short space.

The level of difficulty of the book is uneven, we admit. Most of the book can be followed by attentive readers with no special background, but parts of it, such as the treatment of crystallography, require some college level mathematics. Obviously you do not need our permission to pick and choose what to read.

A word about the halo photographs: Most of them are scans of traditional 35mm slides. Nearly all have been enhanced to some degree using digital unsharp masking. With a few exceptions, the resulting images still show less than was visible in the halo displays themselves. The main exceptions are the lunar halo displays, where, due to the long time exposures required, a slide will sometimes reveal more than was seen at the time of the display. But never have we added anything artificially to the halo photographs.

The degree of enhancement varies from one photo to another throughout the book, but on a given photo the enhancement has been applied uniformly over the entire image, rather than to selected portions, and you will be able to estimate the degree of enhancement by looking for vignetting at what would normally be well-defined edges. In Figure 18.5, for example, the prominent white vignetting of the sun-blocking stick is a sign of strong enhancement.

Well developed halos—and not just the odd radius halos—are beautiful, and so are the atmospheric ice crystals that cause the halos. We think that the science that links the crystals with the halos is beautiful in its own right. We hope you will agree.

Eva Bliembach, Les Cowley, John Hallett, Claudia Hinz, Dixon Jones, Gunther Können, Marko Riikonen, Jukka Ruoskanen, and Eva Seidenfaden all helped with the book, whether they knew it or not, and we want to thank them. We also want to thank everyone who contributed photographs. Special thanks are due our colleague Ken Severin at the Advanced Instrumentation Laboratory, University of Alaska Fairbanks, who contributed the crystal photographs taken with the electron microscope.

This work was supported in part by National Science Foundation grant OPP-9419235. We thank the National Science Foundation for giving us the opportunity to study halos and ice crystals in Antarctica.