

**ANALYSIS OF CONVERSION OF SOLAR ENERGY IN NARROW  
WAVELENGTH REGIMES AS AN ENABLING TECHNOLOGY**

A Dissertation  
Presented to  
The Academic Faculty

By

Clark Kent

In Partial Fulfillment  
of the Requirements for the Degree  
Doctor of Philosophy in the  
School of Physics  
Department of Astronomical Studies

Georgia Institute of Technology

Jan 2020

© Clark Kent 2020

**ANALYSIS OF CONVERSION OF SOLAR ENERGY IN NARROW  
WAVELENGTH REGIMES AS AN ENABLING TECHNOLOGY**

Thesis committee:

Dr. Niles Caulder  
Biomedical Engineering  
*Georgia Institute of Technology*

Dr. Kimiyo Hoshi  
Division of Science  
*Astronomy College of Tokyo*

Dr. Pamela Isley  
Department of Botanical Sciences and  
Agriculture  
*Gotham University*

Dr. Michael Holt  
Department of Physics  
*Georgia Institute of Technology*

Dr. Raymond Palmer  
Department of Physics  
*Ivy University*

Dr. Kent Nelson  
Medical Sciences  
*Georgia Institute of Technology*

Date approved: January 1, 2020

I'm not super. Any talents I have, I worked for – it seems a long time since I thought of myself as a hero.

*Oliver Queen*

For my cousin Kara

## ACKNOWLEDGMENTS

I would like to thank the members of my thesis committee for their help in preparation of this work – Niles Caulder, without whom I would have been doomed to never complete it, Kimiyo Hoshi, who helped to shed new light on many of my ideas, Pamela Isley, with whom I often disagree but who inspires me to be better, Raymond Palmer, who had no small part to play in the formation of the idea, and Kent Nelson, who always had golden advice.

Special thanks are due to the friends and colleagues who made this work possible. Jimmy Olsen and Pete Ross were invaluable both as friends and as sounding boards for some of my more outlandish ideas. Jack Knight, who I met only briefly, was a major influence, and I'm glad we were able to help each other.

The author gratefully acknowledges the support for this work offered by S.T.A.R. Laboratories under grant award number 3X29YZ4A, and by the Theodore S. Kord Fellowship. Any views and conclusions contained herein are those of the author, and do not necessarily represent the official positions, express or implied, of the funders.

## TABLE OF CONTENTS

<b>Acknowledgments</b> . . . . .	v
<b>List of Tables</b> . . . . .	viii
<b>List of Figures</b> . . . . .	ix
<b>List of Acronyms</b> . . . . .	x
<b>Summary</b> . . . . .	xi
<b>Chapter 1: Introduction and Background</b> . . . . .	1
1.1 Stars . . . . .	1
<b>Chapter 2: Methodology</b> . . . . .	3
2.1 The Various Types of Light . . . . .	3
2.1.1 Low-energy photons . . . . .	3
2.1.2 Intermediate-energy photons . . . . .	3
<b>Appendices</b> . . . . .	5
Appendix A: Experimental Equipment . . . . .	6
Appendix B: Data Processing . . . . .	7
<b>References</b> . . . . .	8

**Vita** . . . . . 9

## LIST OF TABLES

1.1	Selected renewable energy installations . . . . .	2
-----	---	---



## LIST OF FIGURES

1.1	Barred spiral galaxy NGC 1300 . . . . .	1
2.1	Black-body radiation . . . . .	4

## **LIST OF ACRONYMS**

**STAR Labs** Scientific and Technological Advanced Research Laboratories

**UV** ultraviolet

## **SUMMARY**

There has been much speculation on whether or not efficient conversion of solar light to energy will have a breakthrough which enables high efficiency, low cost, and enabling of other capabilities previously not thought possible, whether through cellular means, semiconductor based, or otherwise. This work aims to answer some of the questions surrounding these matters.

# CHAPTER 1

## INTRODUCTION AND BACKGROUND

### 1.1 Stars

It is common knowledge that the star closest to Earth is the Sun, and also that the Sun is yellow. It is this yellow sunlight which is interesting for some of its properties [1]. For instance, plants, algae, and cyanobacteria convert this light into energy via photosynthesis. In Figure 1.1 is a photo of a galaxy which contains many stars.



Figure 1.1: Barred spiral galaxy NGC 1300 photographed by Hubble telescope. While the galaxy in the photo is not our sun, it does emit light, much like our sun. Image credit: NASA.

The stars in the sky are of particular interest to the aptly named Scientific and Technological Advanced Research Laboratories (STAR Labs), which in many recent experiments has shown promising results in converting this energy in a non-photoelectric sense into usable energy [2]. Interestingly, STAR Labs has theorized that the famous superhero known as “Superman” converts the light from our sun, which grants his fantastic abilities. There

are many methods in industry for converting the sun's energy (of about  $1000 \text{ W/m}^2$ ) into electrical energy. Some of these are highlighted in Table 1.1.

Table 1.1: Renewable energy installations around the world – the energy generated at these sites is ultimately derived from the sun

installation	type	capacity (GW)	location
Longyangxia Dam	photovoltaic	0.85	China
Gansu Wind Farm	wind	6	China
Sihwa Lake	tidal	0.254	South Korea

## CHAPTER 2

### METHODOLOGY

The process of data collection began with analysis of the physical principles underlying optical light emission. For illustration purposes, see Figure 2.1.

#### **2.1 The Various Types of Light**

Depending on the energy of a photon, it may be referred to as “light” (in the case of optical photons) or as something else – for example, a gamma ray. By convention, there are many names for these particles.

##### 2.1.1 Low-energy photons

The lowest energy electromagnetic radiation is carried by radio waves.

##### 2.1.2 Intermediate-energy photons

These include several types of radiation, including the usually-harmful ultraviolet (UV).

###### *Microwaves*

Microwaves have wavelengths on the order of  $1 \times 10^{-2}$  m, or a few cm.

###### *Visible light*

Visible light is that which is detectable by the human eye, with wavelengths about 380 nm to 750 nm.

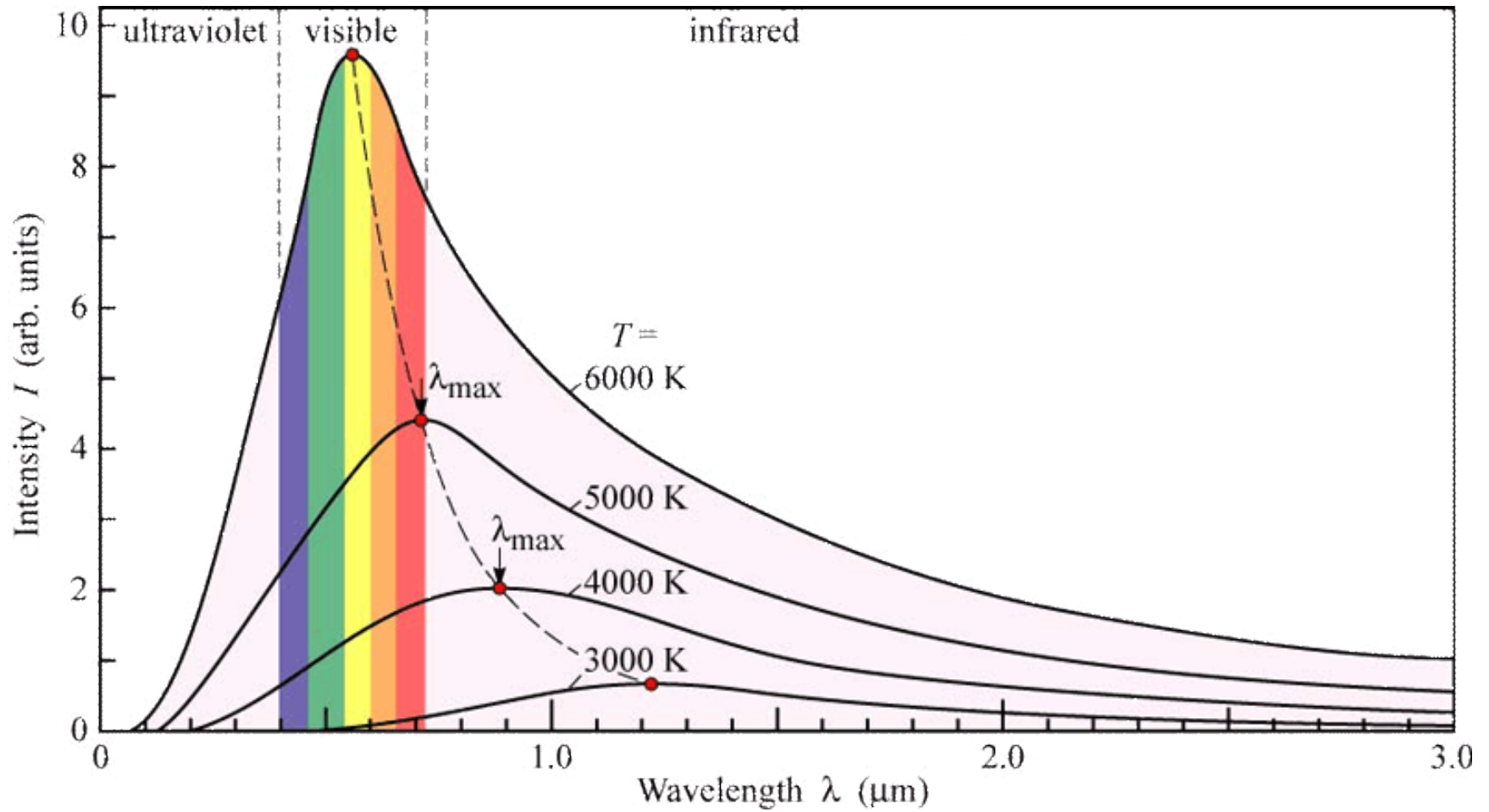


Figure 2.1: Spectra of black-body radiation at various temperatures, according to Wien's displacement law [3].

# **Appendices**



**APPENDIX A**  
**EXPERIMENTAL EQUIPMENT**

A telescope and a spectrometer were used to analyze the sun. Many other instruments were used.

**APPENDIX B**  
**DATA PROCESSING**

Data was processed before being added to this document.

## REFERENCES

- [1] G. D. Scholes, G. R. Fleming, A. Olaya-Castro, and R. Van Grondelle, “Lessons from nature about solar light harvesting,” *Nature chemistry*, vol. 3, no. 10, p. 763, 2011, doi:10.1038/nchem.1145.
- [2] B. Allen and W. West, “Attosecond-length perception of events toward truly sustainable energy,” *Journal of Ultrafast Physics*, vol. 42, no. 1, pp. 43–45, 2019.
- [3] G. Wannier, *Statistical Physics* (Dover Books on Physics). Dover Publications, 1987, ISBN: 9780486654010.

## VITA

Clark Kent was born on April 18, 1938, and adopted by parents Jonathan and Martha Kent in Kansas. He currently resides in the city of Metropolis, where his reporting for the Daily Planet has earned him critical acclaim both at home and abroad. He frequently collaborates with such fellow journalists as his Pulitzer-winning wife Lois Lane, close friend James “Jimmy” Olsen, and longtime editor Perry White.

Clark and Lois enjoy their quiet time together, when they can play with their dog and their teenage son, Jonathan.