HOW DARK MATTER CREATED DARK ENERGY AND THE SUN

An Astrophysics Detective Story

JEROME DREXLER

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This book is dedicated to Sylvia, my wife and lifelong partner.
All royalties from this first edition are being paid directly
to one of her favorite charitable organizations,
Recording for the Blind & Dyslexic, Palo Alto, California.

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PREFACE

Through use of a lecture-slide format, this book presents an astrophysics detective story. It chronicles my search for astronomical clues and evidence to unveil the nature of dark matter. My original goal was to identify dark matter, a decades old mystery. In the process, I developed a new theory for dark matter and believe I have illuminated the nature of dark energy and the process of Sun formation. A unified theory for all three phenomena evolved.

This lecture material was originally prepared as a 30-slide PowerPoint lecture that I had planned to present at a university colloquium. As I proceeded to develop the material, it grew to over 100 presentation slides representing about three lectures. Also, more and more original ideas permeated the material, to the point that the lectures began to look like technical papers on three different subjects – dark matter, the accelerating expansion of the Universe (dark energy), and star (and Sun) formation.

At that point, I decided that the best way of disseminating the information would be to publish the three lectures/technical papers both online and in paperback book form. By these procedures, the lectures could be read by a wider audience.

These lectures are directed toward researchers, professors, postdocs, graduate students, and individuals who majored as undergraduates in astrophysics,

physics, cosmology, astronomy, or related fields. A 90-word glossary is also provided.

My interest in and knowledge of particle physics began early in my professional career. Many years ago at Bell Laboratories in Murray Hill, New Jersey, my seven years of research and development were related to the interaction between microwave electromagnetic waves and electron beams and streams that caused the electrons within them to be bunched, focused, modulated, or deflected. I spent a second seven years working in the same technologies at a company called S-F-D Laboratories, Inc.* that I co-founded in New Jersey with my Bell Labs associates, Dr. Joseph A. Saloom and Dr. Joseph Feinstein. Those 14 years of R&D made me knowledgeable of the behavior of high-speed charged particles under the influence of static magnetic and electric fields and electromagnetic microwaves in a vacuum system, not unlike the behavior of charged particles in the vacuum of outer space.

It was with this background that I began my weekend literature studies of astrophysics, cosmology, and dark matter in 1994 through the analysis of astronomical data and writings. Following the announcements of the accelerating expansion of the Universe and dark energy in 1998 and 1999, those phenomena were added to my studies. By 2001, my focus was on ultra-high-energy

*Multiple SFD 262, SFD 263, or SFD 268 crossed-field amplifiers are used as the microwave power sources in phased-array radars for U.S. Navy Aegis destroyers and cruisers.

(UHE) protons as being the key dark matter constituent. Note that when UHE protons rain on the Earth's atmosphere, we call them cosmic-ray protons, which have been observed by astronomers for about 90 years. By 2002, my research was expanded to seek any possible astronomical or theoretical links between dark matter and dark energy.

The theories developed and conclusions drawn in this book are based upon analyses of astronomical data published by astronomers, astrophysicists, and cosmologists in books, scientific papers, and other literature. Any astronomical data mentioned in this book would have been derived from those other sources, which in most cases are identified. This book is offered as a thought-provoking exploration and analysis and to encourage discussion and debate.

HOW DARK MATTER CREATED DARK ENERGY AND THE SUN

INTRODUCTION

Can the Ultra-High-Energy (UHE) Proton Be a Dark Matter Candidate?

For the past 15 years or more, the world's top astrophysicists and cosmologists have been claiming for various reasons that baryons (protons or neutrons) could not be the principal constituent of dark matter. Unfortunately, my favorite dark matter candidate, ultra-high-energy (UHE) protons, happens to be a baryon. Some astrophysicists have been proposing the WIMP (weakly interacting massive particle), a heavy theoretical non-baryonic particle, as their favorite candidate, which has some similarities to the neutralino, a heavy theoretical non-baryonic particle, being proposed today.

The UHE proton as a dark matter candidate has several key advantages over the theoretical WIMP and neutralino particles (which have never been detected). The cosmic-ray protons are real and have been detected by astronomers for about 90 years. Further, a cosmic-ray proton has an enormous kinetic energy ranging from 10^{10} electron volts to 10^{20} electron volts and therefore has an enormous relativistic mass and an enormous gravitational attraction – orders of magnitude greater than those of the theoretical WIMP and neutralino.

The UHE proton is also difficult to detect by astronomical methods – a necessary characteristic for dark matter particles.

Could Cosmic-Ray Protons Play a Leading Role in Creating the Sun?

If cosmic-ray protons are a principal constituent of dark matter, they might have been involved in creating the Milky Way, its stars, and our Sun. In late 2002, I tested that concept by using a comment in Herbert Friedman's famous 1998 book entitled, *The Astronomer's Universe*. Friedman wrote, "Eventually, balloon-borne experiments proved that cosmic rays are charged particles consisting mostly of hydrogen nuclei (protons), helium nuclei (alpha particles), a few heavier nuclei, and electrons. All told, about 1 - 2 pounds per day arrive at the earth."

It occurred to me that the density of 1 to 2 pounds per day onto the Earth might be representative of the cosmic-ray particle density raining onto the entire solar system region during the last 13.5 billion years. Could those cosmic-ray protons and other cosmic particles have added any significant mass to the Sun? I did some math and discovered that the cumulative cosmic-ray particle mass showering the solar system region over 13.5 billion years would be in the range of about 3×10^{30} to 6×10^{30} kilograms. I was very encouraged when I compared that accumulated cosmic-ray particle mass to astronomers' standard estimate of the mass of the Sun at 2×10^{30} kilograms. Not only are the two mass quantities close, but the Sun's mass is lower, which is a more plausible expectation.

UHE Protons and Cosmic-Ray Protons Exhibit a Characteristic Normally Expected of Dark Matter Particles.

Many cosmologists, and I, have believed that dark matter was somehow utilized in creating the galaxies and the stars. Now, there is some circumstantial evidence that the mass of the Sun may have been derived from the mass of cosmic-ray protons and helium nuclei raining upon the solar system for 9 billion years originally, and for another 4.5 billion years since the birth of the Sun. This seems to provide support that the cosmic-ray protons may have been instrumental in creating the Sun; and, if true, that cosmic-ray protons and their source, UHE protons, may be the long-sought dark matter particles.

Halo UHE Protons Seem to Be the Source of Galaxy Cosmic-Ray Protons.

However, the long-sought dark matter particles seem to reside in a thick halo around spiral galaxies and galaxy clusters. If UHE cosmic-ray protons are dark matter particles, what would keep them in the halo of galaxies and galaxy clusters? My answer is that the extragalactic magnetic field strength, which is very weak but has just the right strength to keep the positively charged very high speed UHE protons in circular and spiral orbits around galaxies. The dark matter halo has a thickness which is probably created by UHE protons having various kinetic energies and therefore different spiral path diameters in the extragalactic magnetic field of the galaxy halo.

What Causes the Transformation from UHE Protons to Cosmic-Ray Protons?

The next question is, why do the UHE protons fall to Earth as cosmic-ray protons? The following lectures explain how the UHE protons moving in the extra-galactic magnetic field lose energy slowly through what is called synchrotron radiation, which causes them to slow down. This reduces the size and the radius of curvature of their spiral orbits, causing the synchrotron radiation to increase further. Finally, when UHE protons encounter the higher magnetic field of the Milky Way galaxy, their synchrotron radiation losses skyrocket and the protons plunge into the galaxy as cosmic-ray protons, in what I call a "death spiral."

The Accelerating Expansion of the Universe Is Between Galaxy Clusters.

Another significant step in developing the basis for the lectures was achieved when I developed a theory to explain the accelerating expansion of the Universe utilizing relativistic UHE protons, the galactic and extragalactic magnetic fields, and two principles of physics.

In 1929, Edwin P. Hubble announced that with the exception of the galaxies closest to the Milky Way, galaxies are rushing away from each other in all directions and, therefore, the Universe is expanding. Maybe the word "expanding" should have been in quotes since the solar system is not expanding, the Milky Way galaxy is not expanding, and in the Local

Group of galaxies, the Milky Way and the Andromeda galaxy are actually moving toward each other.

That is, Hubble's expanding Universe discovery is that, at the greatest distances, galaxy clusters are all moving away from one another. For many years, it was not realized that the expansion was accelerating. Analyses of ancient supernova explosions in distant galaxies during the period 1998-2003 disclosed that the separation velocities between galaxy clusters have been increasing, making the Universe expand faster and faster. This accelerating expansion phase apparently began about 5 billion years ago.

In searching for an explanation for the accelerating expansion of the Universe, I felt the most significant clue I had was that it only applies to the separation of galaxy clusters and not to the separation of galaxies or stars within a galaxy. This sent me a message that the sought-after explanation seemed to be associated with some phenomenon, rather than a field theory like antigravity. Another important clue that helped me confirm the theory I had already developed, was that the expansion acceleration began about 5 billion years ago.

When I began focusing on the mystery of accelerating expansion, I already had established in my mind the strong dark-matter candidacy of the relativistic UHE proton, which could be the principal constituent of the dark matter halos around spiral galaxies and galaxy clusters. Could the relativistic UHE protons help provide a plausible explanation for the accelerating expansion?

Having made the mental connection between galaxy clusters and their halos comprising UHE proton dark matter, it occurred to me, for several reasons, that two well-established principles of physics might lead me to a plausible explanation for the accelerating expansion of the separation between galaxy clusters. They are:

(1) When relativistic protons pass through the extra-galactic or galactic magnetic fields, they are deflected into spiral paths, causing them to generate synchrotron radiation which in turn causes them to lose kinetic energy and to thereby lose relativistic mass; and

(2) The linear momentum of an object equals the product of its mass and its velocity. If no external forces are acting on a group of galaxy clusters, the Law of Conservation of Linear Momentum requires that the total linear momentum of all the galaxy clusters in the group shall remain constant.

In the lectures, these concepts are developed into an explanation and theory for the accelerating expansion of the Universe.

The Focus of the Lecture Slides.

Four principal points are the focus of the lecture slides comprising this manuscript:

(1) Dark matter is simply ultra-high-energy (UHE) protons circulating around galaxies and galaxy clusters in a very thick halo.

(2) The minuscule magnetic fields of the extragalactic Universe and the slightly higher magnetic fields of galaxies may be small, but they control the spiral paths and life spans of the powerful and multitudinous UHE protons.

(3) The accelerating expansion of the Universe probably comes about by the continual loss of relativistic mass of the dark matter halos around galaxy clusters, which reduces their gravitational attraction and also causes those clusters to automatically speed up to maintain their linear momentum under the Law of Conservation of Linear Momentum.

(4) It appears that the Sun may have been created by UHE protons that had been circulating in the dark matter halo around the Milky Way but had plunged into the Milky Way in the form of cosmic-ray protons after losing a very large percentage of their energy due to synchrotron radiation.

In the following slide-format lectures, the explanations for dark matter, accelerating expansion of the Universe (which some cosmologists attribute to dark energy), and star (and Sun) formation are all based upon a unified theory which involves UHE protons traveling through at least two levels of weak magnetic field strengths. Only 20th century physics is employed, and only known types of particles are utilized.

With that said, let the lectures begin.

LECTURE:

HOW DARK MATTER CREATED DARK ENERGY AND THE SUN

PART I

THE DISCOVERY AND MYSTERY OF DARK MATTER

SLIDE #1

Dr. Fritz Zwicky Discovered and Dr. Vera Rubin Confirmed That A Dark Matter Halo Surrounds Spiral Galaxies and Clusters

- In 1933, Fritz Zwicky, an astrophysicist at the California Institute of Technology, was studying a nearby cluster of galaxies called the Coma cluster. He observed some galaxies in the cluster traveling at unexpectedly high speeds. Since the observable mass in the cluster was not sufficient to provide the gravity needed to hold galaxies moving at such high speed, he felt there must be a great halo of invisible mass surrounding the cluster.

- In 1977, Vera Rubin and her associates at the Carnegie Institution studied the rotation curves of galaxies by measuring the Doppler velocities of stars in various locations within 60 spiral galaxies. The rotation curves for the stars were nearly flat, indicating that a halo of invisible mass must surround each galaxy.

SLIDE #2

Dark Matter – Astronomers Cannot See Dark Matter With Their Telescopes

- Despite the absence of telescopic evidence, astronomers believe in the presence of dark matter because they detect its gravitational influence or because certain theories predict its existence. They believe that the halo of spiral galaxies harbors dark matter because they notice its gravitational influence on the stars they can see.

- Inflationary cosmologists, who believe the Universe will continue to expand, also believe that the Universe is full of dark matter because inflation theory predicts that the Universe has a large mass density.

- Inflationary cosmologists believe that particle synthesis during the Big Bang would not create enough protons and helium nuclei to achieve the large mass density necessary for continued expansion of the Universe.

SLIDE #3

The Dark Matter Halo Is the Massive Outer Region Of a Spiral Galaxy

- The dark matter halo is the massive outer region of the Milky Way that surrounds the disk and stellar halo. The dark matter halo consists mostly of dark matter particles whose form has been unknown. Though it emits almost no light, the dark matter outweighs the ordinary matter in the galaxy by a factor of about five.

- Studies in 1999 found that the dark matter halo of a spiral galaxy extends much farther into space than previously estimated, extending 10 to 20 times the size of the visible regions of the galaxies rather than 4 to 6 times.

SLIDE #4

There Is About Five Times as Much Dark Matter as Ordinary Baryonic Galaxy Matter

Many cosmologists believe that the ordinary baryonic matter (protons and neutrons) of stars, galaxies, and gas accounts for no more than 5% of the mass of the Universe. They believe the invisible or dark matter that has so far eluded detection by the best instruments of astronomy or particle physics accounts for about 25% of the mass of the Universe and that dark energy, which causes the expansion of the Universe to accelerate, accounts for the remainder. (See slide #11.)

SLIDE #5

"It Would Be Impossible to Build a Universe Made Only Out of Baryons," States MIT's Dr. Alan H. Guth

- One reason that dark matter is required by cosmologists is that ordinary matter, known collectively as baryons, would not have coalesced quickly enough around the embryonic mass fluctuations, according to Dr. Alan H. Guth, an astrophysicist at the Massachusetts Institute of Technology. Ordinary matter would not have immediately been attracted to the weak gravity of the primordial ripples; certain kinds of dark matter could have been.

- "Even before COBE [Cosmic Background Explorer] there were strong suggestions that it would be impossible to build a Universe made only out of baryons," Dr. Guth said, and "COBE helps nail down that conclusion."

SLIDE #6