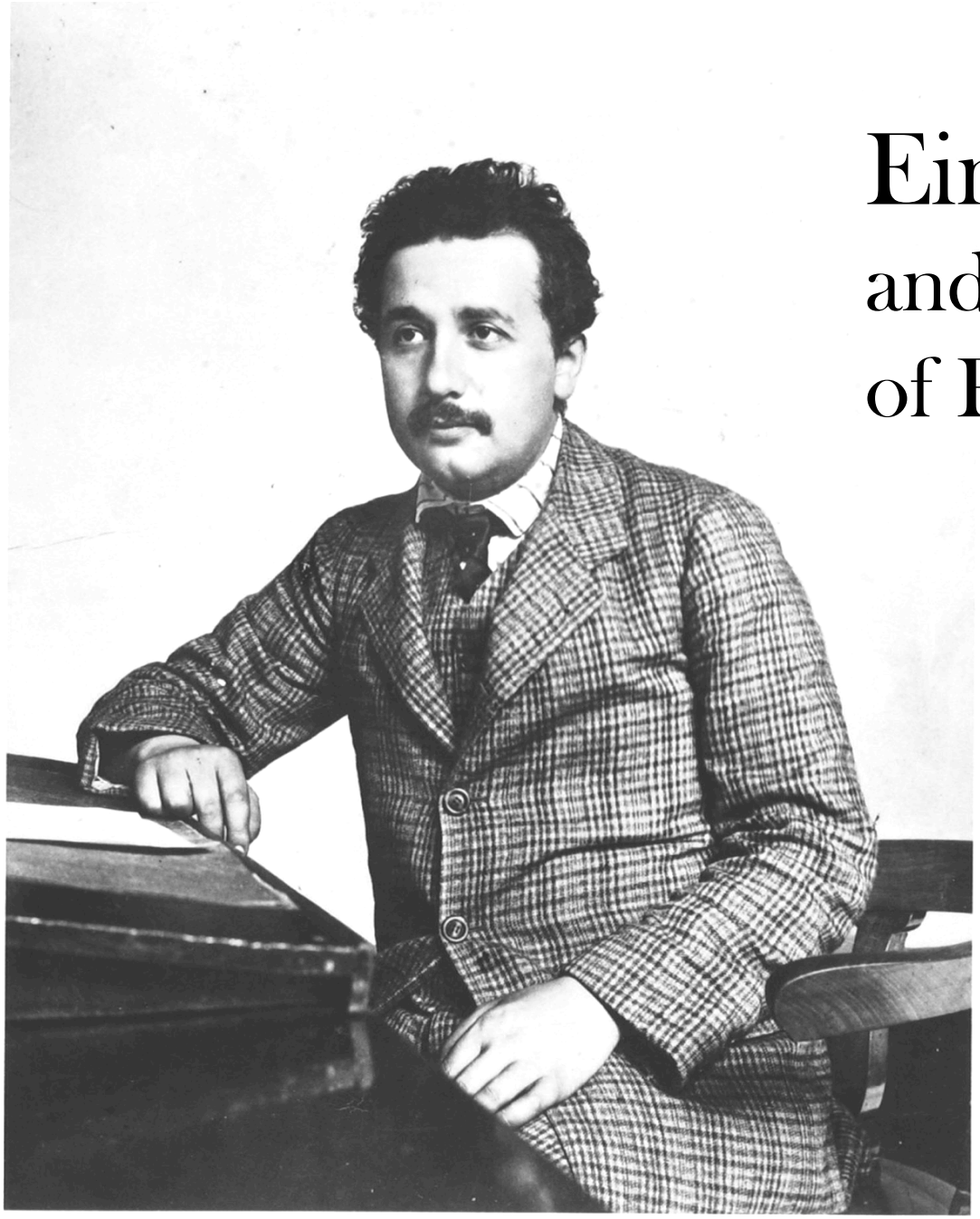
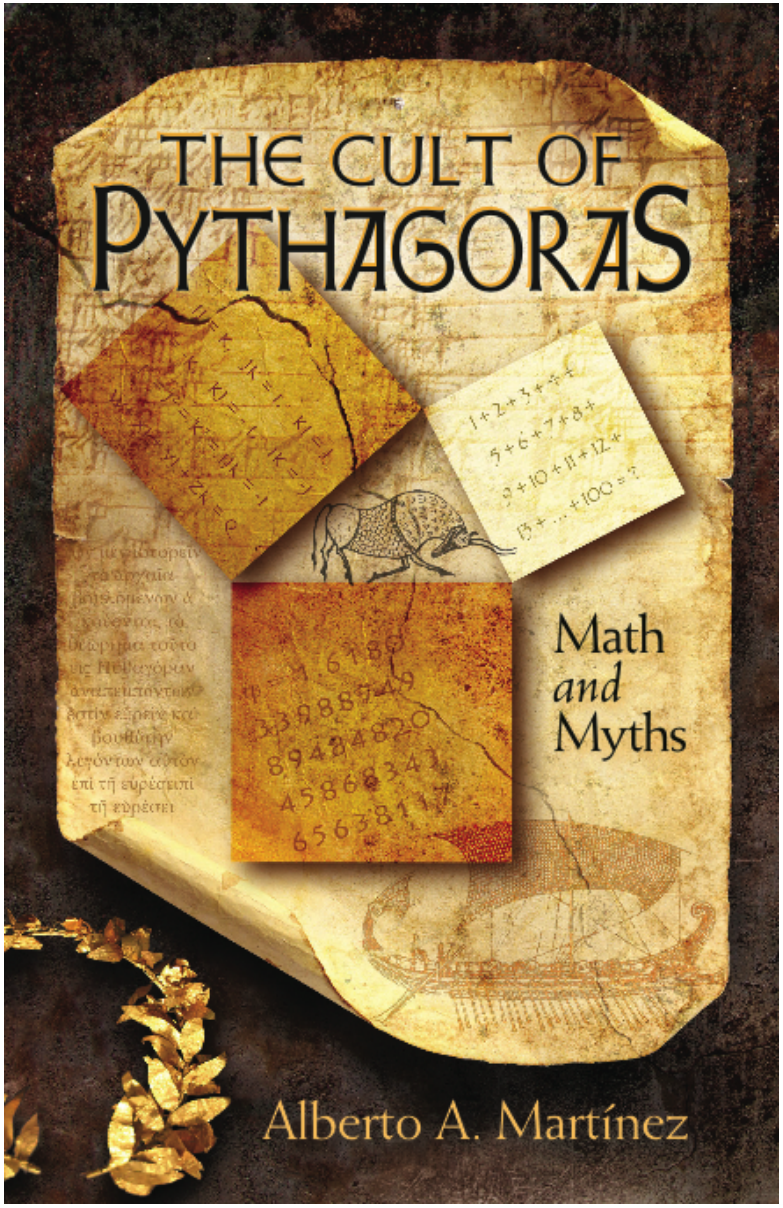


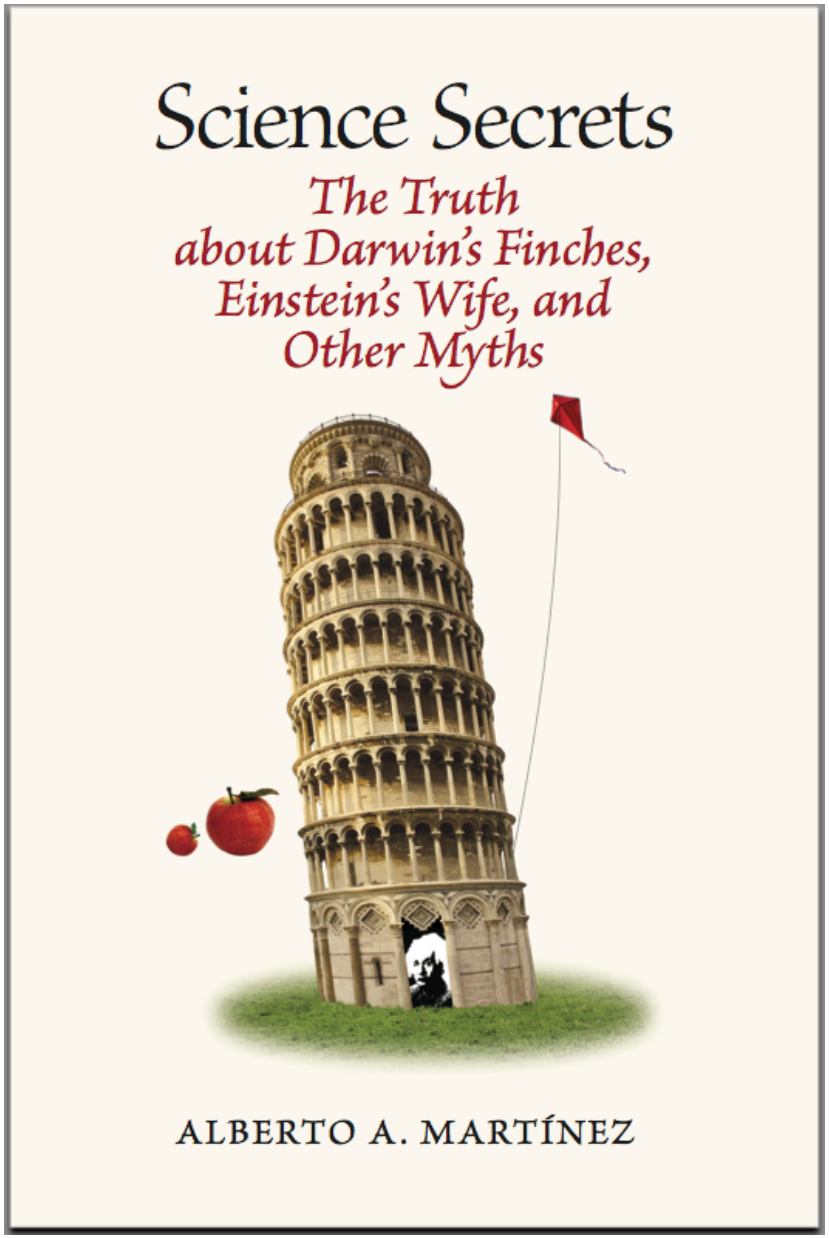
Einstein, Darwin and the Importance of Primary Sources

Dr. Alberto Martínez
Associate Professor
Department of History

University of Texas at Austin
July 26, 2013

Texas STEM
2013 Librarians' Conference


THE CULT OF
PYTHAGORAS
Math
and
Myths
Alberto A. Martínez


Science Secrets
The Truth
about Darwin's Finches,
Einstein's Wife, and
Other Myths
ALBERTO A. MARTÍNEZ

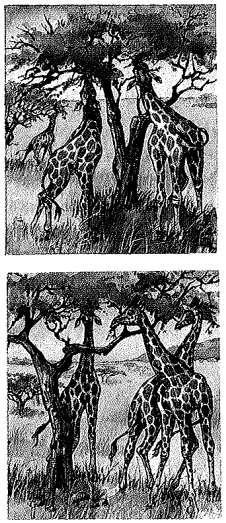


FIGURE 10.5
According to Lamarck, when short-necked giraffes stretched their necks to reach leaves high on a tree, their necks became longer. The longer neck was then passed on to the offspring. What principles of Lamarck's hypothesis are represented here?

First, Lamarck thought that organisms constantly strive to improve themselves. Second, he believed that the most-used body structures develop, whereas unused structures waste away. This idea was called the principle of use and disuse. Third, Lamarck thought that once a structure is modified by use or disuse, the modification is inherited by the organism's offspring. This third principle is called the inheritance of acquired characteristics. Study ***Figure 10.5*** to see how Lamarck's hypothesis explains the evolution of the giraffe's long neck.

Lamarck published some of his ideas on evolution in 1809, the same year Charles Darwin was born. His work had a strong influence on Darwin. Lamarck's hypothesis about the inheritance of acquired characteristics was later disproved by German biologist August Weismann. Through experiments with mice, Weismann concluded that changes in an individual during its lifetime do not affect its reproductive cells or its offspring.

INFLUENCES ON DARWIN

Interdisciplinary studies

In 1831 Charles Darwin joined an around-the-world trip on a ship called the HMS *Beagle*. As you read at the beginning of this chapter, Darwin used the trip as an opportunity to collect plant samples and study animal species from the shore.

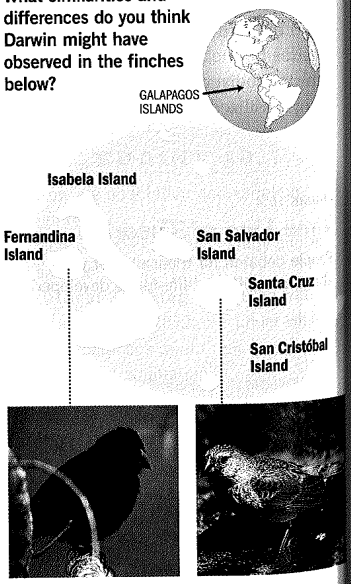
Darwin was especially intrigued by the finches he observed, such as those shown in ***Figure 10.6***. Darwin observed that each different group of finches had its own niche. This led Darwin to wonder whether each group of finches was a different species.

Darwin later learned that the 13 different finches he had studied were indeed separate species. Each species was suited to the environment of its niche. Darwin hypothesized that the adaptations of animals to their environment and the emergence of new species were closely related processes.

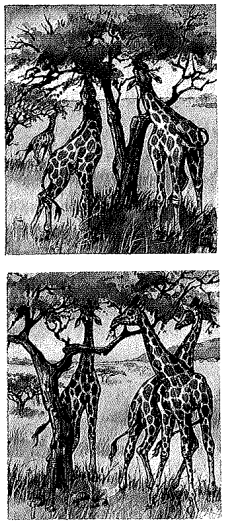
Geology After Darwin returned home, he spent a great deal of time studying his notes, reading, and conversing with colleagues. From the books of his friend Charles Lyell, Darwin learned that geological change is an extremely slow, uniform process. Lyell reasoned that Earth must be very old. Using Lyell's hypothesis, Darwin concluded that gradual geological changes over long periods of time influence plant and animal life.

Artificial selection Darwin also studied the selective breeding of domestic animals and crops. By selecting a parental generation with the

FIGURE 10.6
Darwin studied finches as he sailed to the Galapagos Islands. What similarities and differences do you think Darwin might have observed in the finches below?



Eric Strauss and Marylin Lisowski,
Biology: The Web of Life
(Scott Foresman - Addison Wesley, 1998).



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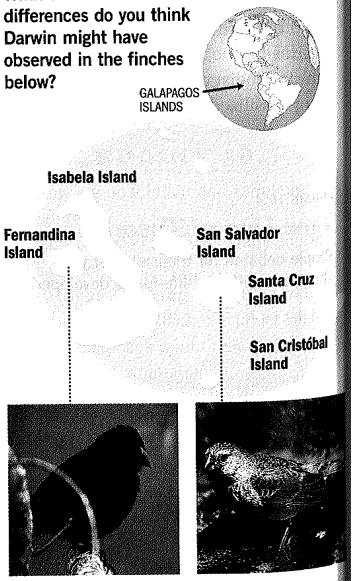

Eric Strauss and Marylin Lisowski,
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As we saw in chapter 20, a variety of different processes can result in evolutionary change. Nonetheless, in agreement with Darwin, most evolutionary biologists would agree that natural selection is the process responsible for most of the major evolutionary changes that have occurred through time. Although we cannot travel back through time, a variety of modern-day evidence confirms the power of natural selection as an agent of evolutionary change. These data come from both the field and the laboratory and from natural and human-altered situations.

The Beaks of Darwin's Finches

Darwin's finches are a classic example of evolution by natural selection. Darwin collected 31 specimens of finch from three islands when he visited the Galápagos Islands off the coast of Ecuador in 1835. Darwin, not an expert on birds, had trouble identifying the specimens, believing by examining their bills that his collection contained wrens, "grossbeaks," and blackbirds. You can see Darwin's sketches of four of these birds in figure 21.8.

The Importance of the Beak

Upon Darwin's return to England, ornithologist John Gould examined the finches. Gould recognized that Darwin's collection was in fact a closely related group of distinct species, all similar to one another except for their bills. In all, there were 13 species. The two ground finches with the larger bills in figure 21.8 feed on seeds that they crush in their beaks, whereas the two with narrower bills eat insects. One species is a fruit eater, another a cactus eater, yet another a "vampire" that creeps up on seabirds and uses its sharp beak to drink their blood. Perhaps most remarkable are the tool users, woodpecker finches that pick up a twig, cactus thorn, or leaf stalk, trim it into shape with their bills, and then poke it into dead branches to pry out grubs.

The correspondence between the beaks of the 13 finch species and their food source immediately suggested to Darwin that evolution had shaped them:

> "Seeing this gradation and diversity of structure in one small, intimately related group of birds, one might really fancy that from an original paucity of birds in this archipelago, one species has been taken and modified for different ends."

Was Darwin Wrong?

If Darwin's suggestion that the beak of an ancestral finch had been "modified for different ends" is correct, then it ought to be possible to see the different species of finches acting out their evolutionary roles, each using their bills to acquire their particular food specialty. The four species that crush seeds within their bills, for example, should feed on different seeds, those with stouter beaks specializing on harder-to-crush seeds.

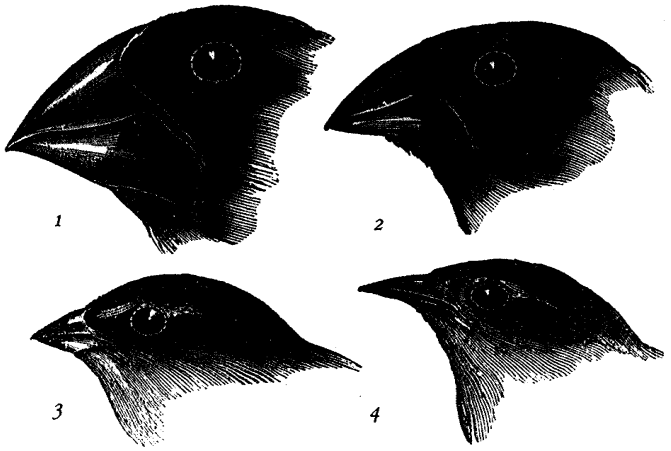

FIGURE 21.8
Darwin's own sketches of Galápagos finches. From Darwin's *Journal of Researches:* (*1*) large ground finch *Geospiza magnirostris;* (*2*) medium ground finch *Geospiza fortis;* (*3*) small tree finch *Camarhynchus parvulus;* (*4*) warbler finch *Certhidea olivacea.*

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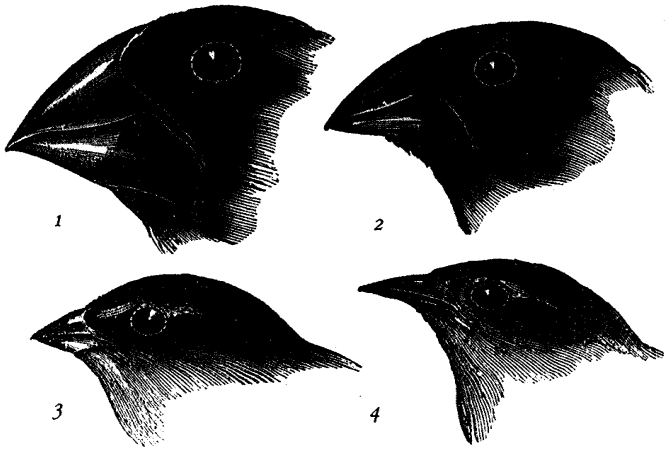

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myth:
that finches inspired Darwin to evolution

Peter H. Raven and George B. Johnson,
Biology, Sixth Edition
(McGraw-Hill , 2002).

FUEGIAN.

(FAPIGI VERSIMILIS.)

Published by Henry Colburn, Great Marlborough Street, 1839.

NARRATIVE

OF THE

SURVEYING VOYAGES

OF HIS MAJESTY'S SHIPS

ADVENTURE AND BEAGLE,

BETWEEN

THE YEARS 1826 AND 1836,

DESCRIBING THEIR

EXAMINATION OF THE SOUTHERN SHORES

OF

SOUTH AMERICA,

AND

THE BEAGLE'S CIRCUMNAVIGATION OF THE GLOBE.

IN THREE VOLUMES.
VOL. II.

LONDON:
HENRY COLBURN, GREAT MARLBOROUGH STREET.

1839.

ON

THE ORIGIN OF SPECIES

BY MEANS OF NATURAL SELECTION,

OR THE

PRESERVATION OF FAVOURED RACES IN THE STRUGGLE FOR LIFE.

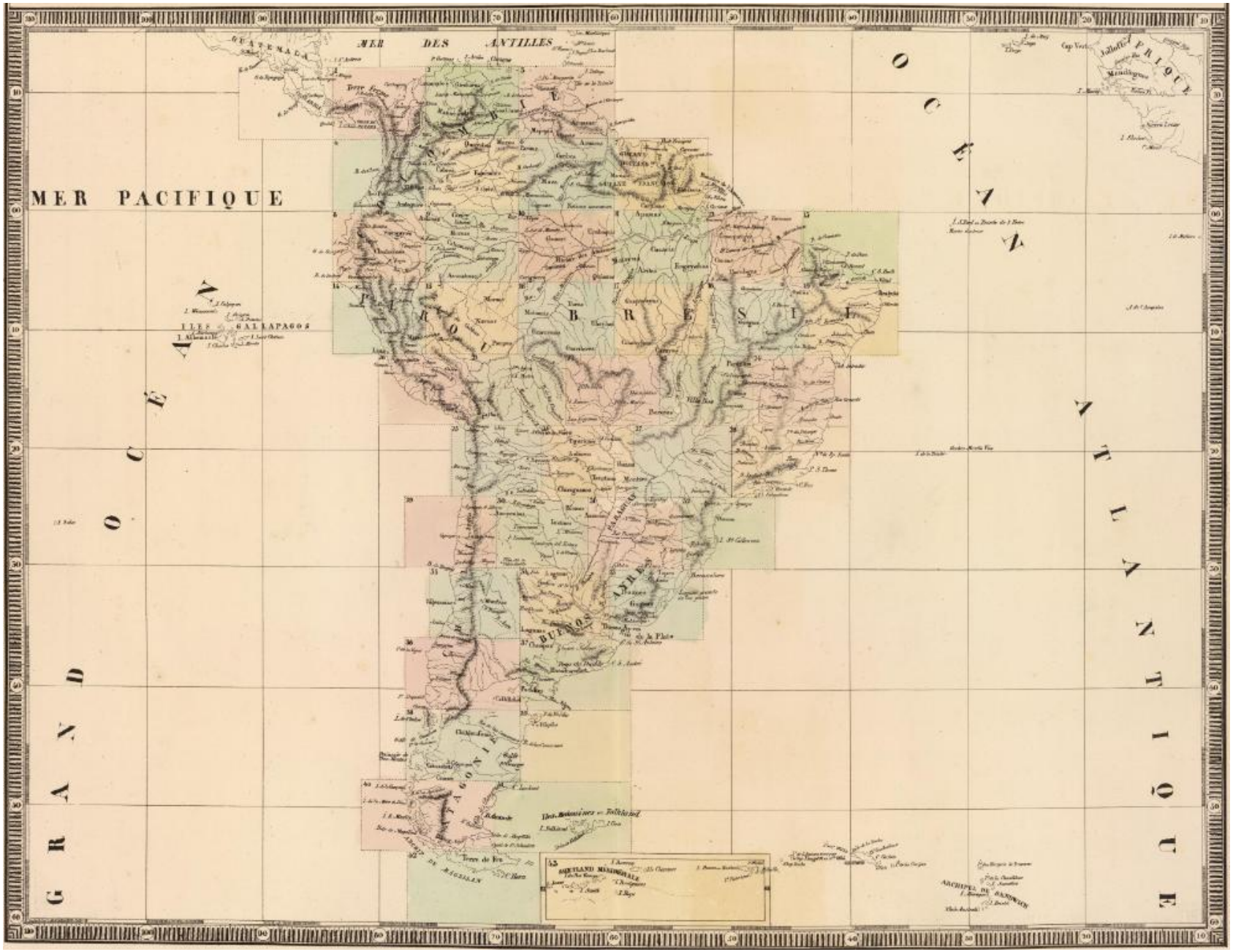
By CHARLES DARWIN, M.A.,

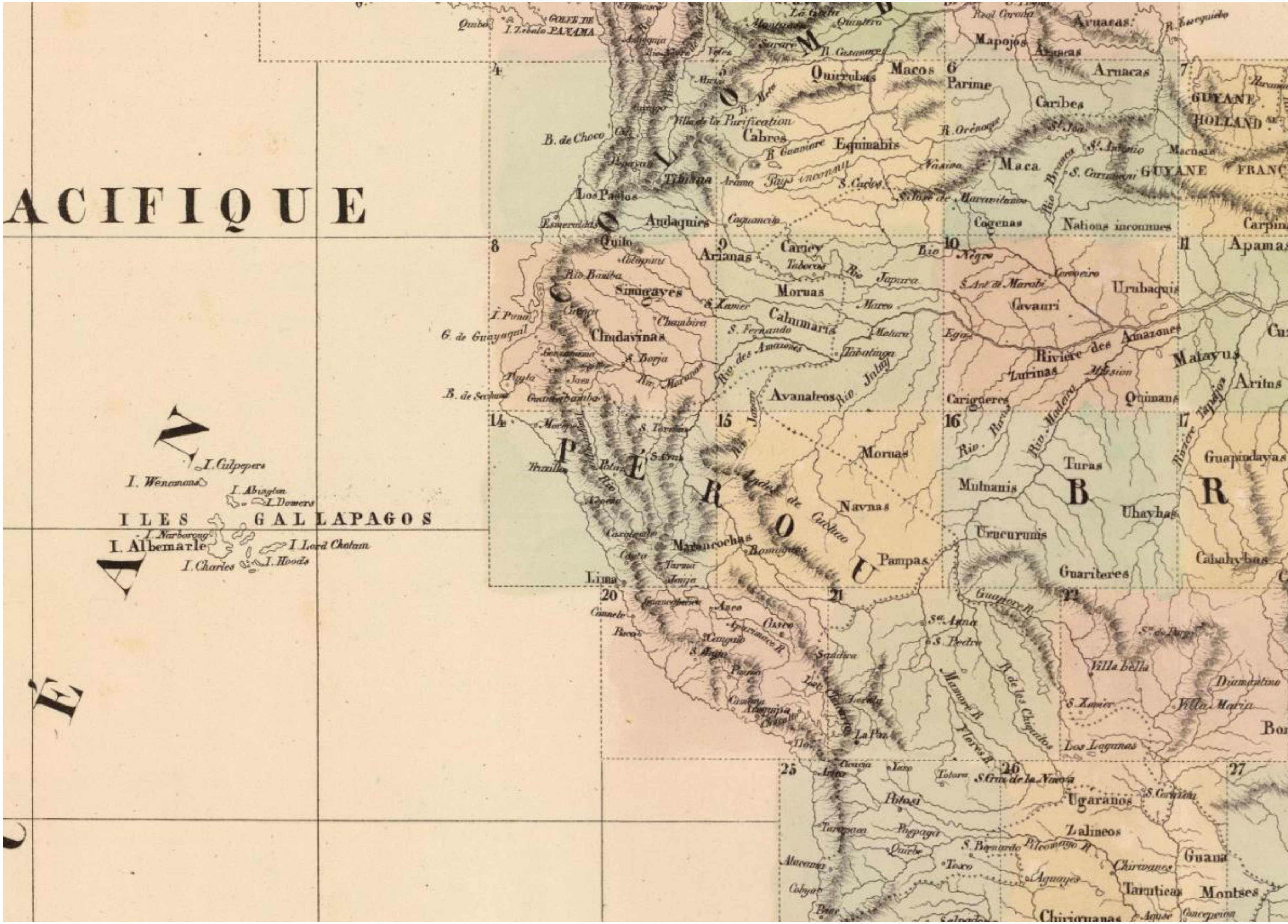
FELLOW OF THE ROYAL, GEOLOGICAL, LINNÆAN, ETC., SOCIETIES;
AUTHOR OF 'JOURNAL OF RESEARCHES DURING H. M. S. BEAGLE'S VOYAGE ROUND THE WORLD.'

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1859.

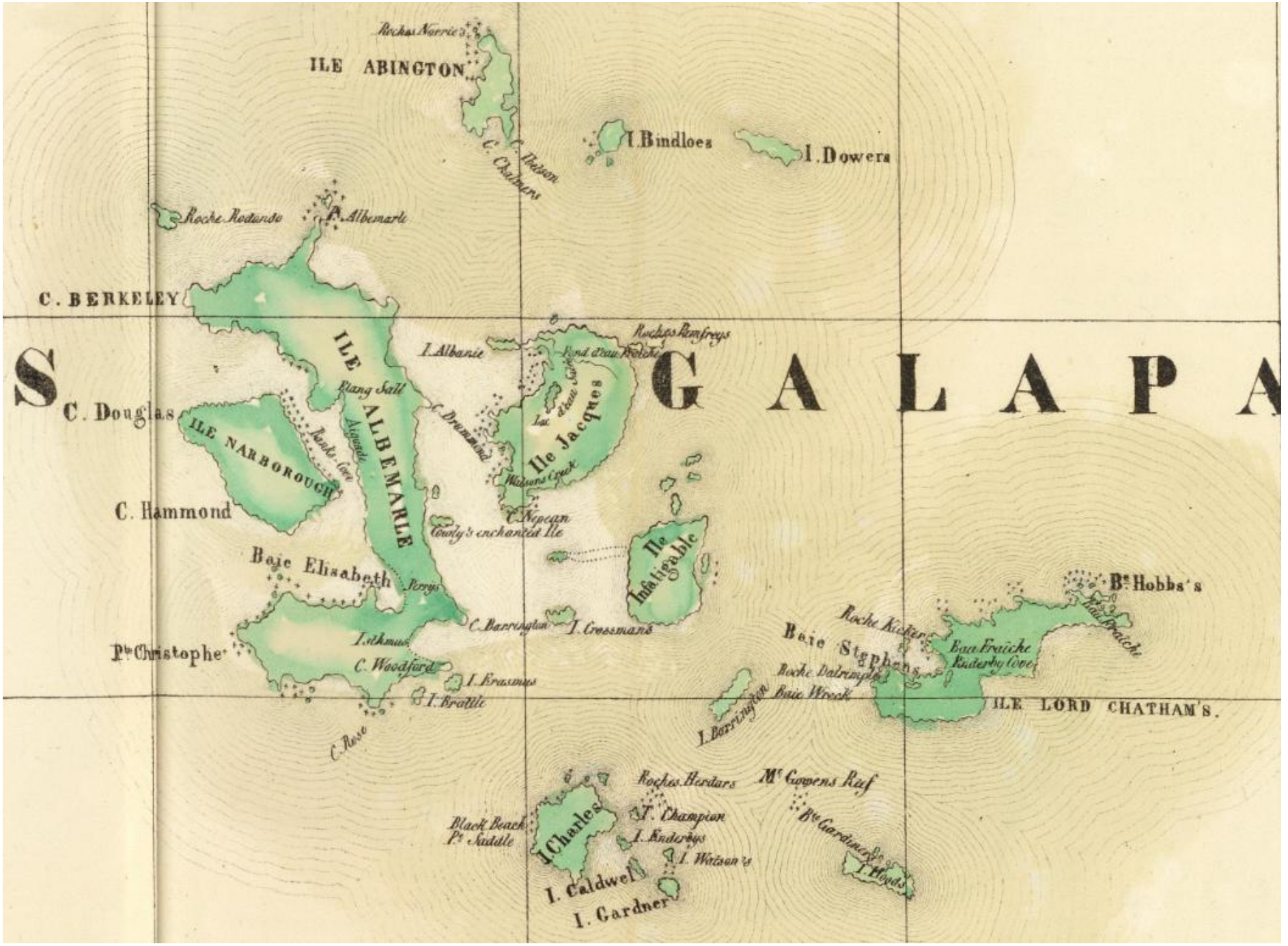
1835	Charles Darwin visits the Galápagos and collects animals, including birds.	
1837	John Gould	Darwin collected 13 species of Galápagos finches having different beaks while their plumage is nearly identical, by contrast to finches on the continents.
1839	Darwin's *Narrative of the Surveying Voyages*	"All the species [of finches], excepting two, feed in flocks on the ground, and have very similar habits. It is very remarkable that a nearly perfect gradation of structure in this one group can be traced in the form of the beak"…. "I very much **suspect**, that certain members of the series are confined to different islands…"
1845	Darwin's *Journal of Researches*	Illustration of four finches. "Seeing this gradation and diversity of structure in one small, intimately related group of birds [finches], **one might really fancy** that from an original paucity of birds in this archipelago, one species had been taken and modified for different ends."
1859	Darwin's *Origin of Species*	No comments on the finches of the Galápagos. "**I felt fully as much difficulty in believing** that they [pigeons] could ever have descended from a common parent, as any naturalist could in coming to a similar conclusion in regard to the many species of finches, or other large groups of birds, in nature."
A hundred years later…		
1944-1983	David Lack	"…in 1835, Charles Darwin collected some dull-looking finches in the Galapagos Islands. They proved to be a new group of birds and, together with the giant tortoises and other Galapagos animals, they started a train of thought which culminated in the *Origin of Species*, and shook the world."
1977	Stephen Jay Gould	"tortoises and finches have always received the nod as primary agents in the transformation of Darwin's world view"
1982	Frank Sulloway	Finches did not inspire Darwin to his theory.
1999	Raven and Johnson *Biology*	"the correspondence between the beaks of the 13 finch species and their food source immediately suggested to Darwin that evolution had shaped them."

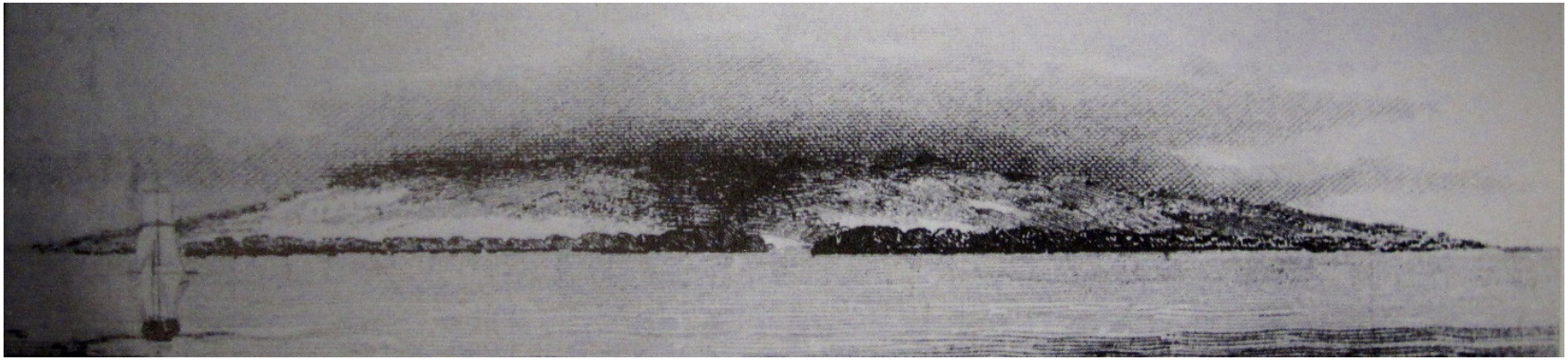
1835	Darwin's notes about Galápagos birds, written during the Beagle voyage	Abundant species of tame finches exhibit "an inexplicable confusion," and "a gradation in the form of the bill," with "no possibility of distinguishing the species by their habits, as they are all similar, & they feed together..."
		Two of four specimens of mockingbirds are distinct kinds *exclusive* to two islands; and some Spaniards claim to know from which island came any tortoise—such remarks might "undermine the Stability of species," and should be examined.
1837-1838	Darwin's notebooks on transmutation	No comments on the finches of the Galápagos
1857	Darwin's big manuscript on Natural Selection	"I suppose that nearly all the birds had to be modified, I may say improved by selection in order to fill as perfectly as possible their new places; some as Geospiza [finches], probably the earliest colonists, having undergone far more change than the other species; Geospiza now presenting a marvelous range of difference in their beaks..."


MER DES ANTILLES
MER PACIFIQUE
OCEAN ATLANTIQUE
GRAND OCEAN
GUATEMALA
ILES GALLAPAGOS
PEROU
BRESIL
PARAGUAY
BUENOS AYRES
PATAGONIE
Terre de Feu
ARCHIPEL DE SANDWICH



ACIFIQUE
ILES GALLAPAGOS
I. Gilpepers
I. Wenmans
I. Abington
I. Dowers
I. Narborong
I. Albemarle
I. Lord Chatam
I. Charles
I. Hoods
GOLFE DE PANAMA
I. Zebalo
Quibo
B. de Choco
Los Pastos
Esmeraldas
Quito
Andaquies
Arianas
Cariey
Moruas
Simigayes
Rio Bamba
I. Puna
G. de Guayaquil
Chambira
Chudavinas
S. Borja
B. de Sechura
Jaen
S. Xavier
S. Fernando
Calumaris
Rio des Amazones
Tabatinga
Avanateos
Rio Japura
Rio Negro
S. Ant. de Marabi
Gavauri
Urubaquis
Egas
Rivière des Amazones
Zurinas
Mission
Matayus
Aritus
Quimans
Carigueres
Apamas
Cogenas
Nations inconnues
Carpinas
S. Carlos
Pays inconnu
Cabres
Equinabis
R. Guaviare
R. Orénoque
Villa de la Purification
Quirrubas
Macos
Parime
Caribes
Arnacas
Mapojos
Aruacas
Maca
R. Casanare
GUYANE HOLLAND.SE
GUYANE FRANÇ
Macusis
S. Joaquin
Rio Branco
B.e Tinima
PÉROU
Andes de Cuchao
Moruas
Navnas
Pampas
Maraucochas
Truxillo
S. Cruz
Rio Madeira
Rio Jutay
Mutuanis
Turas
Ubayhas
Urucurunis
Guariteres
Guapindayas
Cabahybas
Guaporé R.
Villa bella
Diamantino
Villa Maria
S. Xavier
Los Lagunas
Lima
Canete
Pisco
Anco
Cusco
Arequipa
La Paz
Arica
Potosi
Tarapaca
S. Cruz de la Sierra
Ugaranos
Zalineos
Pilcomayo R.
Chiriguanas
Guana
Tarutica
Montses
Atacama
Cobija
Concepcion
Mamoré R.
R. de los Chiquitos
Flores R.
Sa. Anna
S. Pedro
S. Borja
Tabatinga


Roches Narrie's
ILE ABINGTON
C. Chalmers
C. Dotson
I. Bindloes
I. Dowers
Roche Redonda
P. Albemarle
C. BERKELEY
S
GALAPA
Roches Remfreys
I. Albanie
ILE ALBEMARLE
Plang Salt
C. Douglas
ILE NARBOROUGH
Beach Cove
Aiguada
C. Drummond
Ile Jacques
Watsons Creek
C. Hammond
C. Napean
Cowly's enchanted Ile
Ile Inaccessible
Baie Elisabeth
Perrys
C. Barrington
I. Grossmans
Pte Christophe
I. Isthmus
C. Woodford
I. Erasmus
I. Brattle
C. Rose
Pte Hobbs's
Roche Kickers
Baie Stephens
Roche Dalrimple
Baie Wreck
I. Barrington
ILE LORD CHATHAM'S.
Roches Berdars
Mr Gowens Ruf
Black Beach Pte Saddle
I. Charles
I. Champion
I. Enderbys
I. Watson's
I. Caldwell
I. Gardner
I. Hoods



While visiting the Galápagos islands, Charles Darwin noticed that various species of finches had beaks of different shapes and sizes. Observing their eating habits, he noticed that the shapes of their beaks corresponded to their diets. He also noticed that some species were distinct to some islands. Hence he inferred that the various species were related: they were descended from common ancestors that had populated the islands and had adapted variously to the distinct island conditions. Species evolved.

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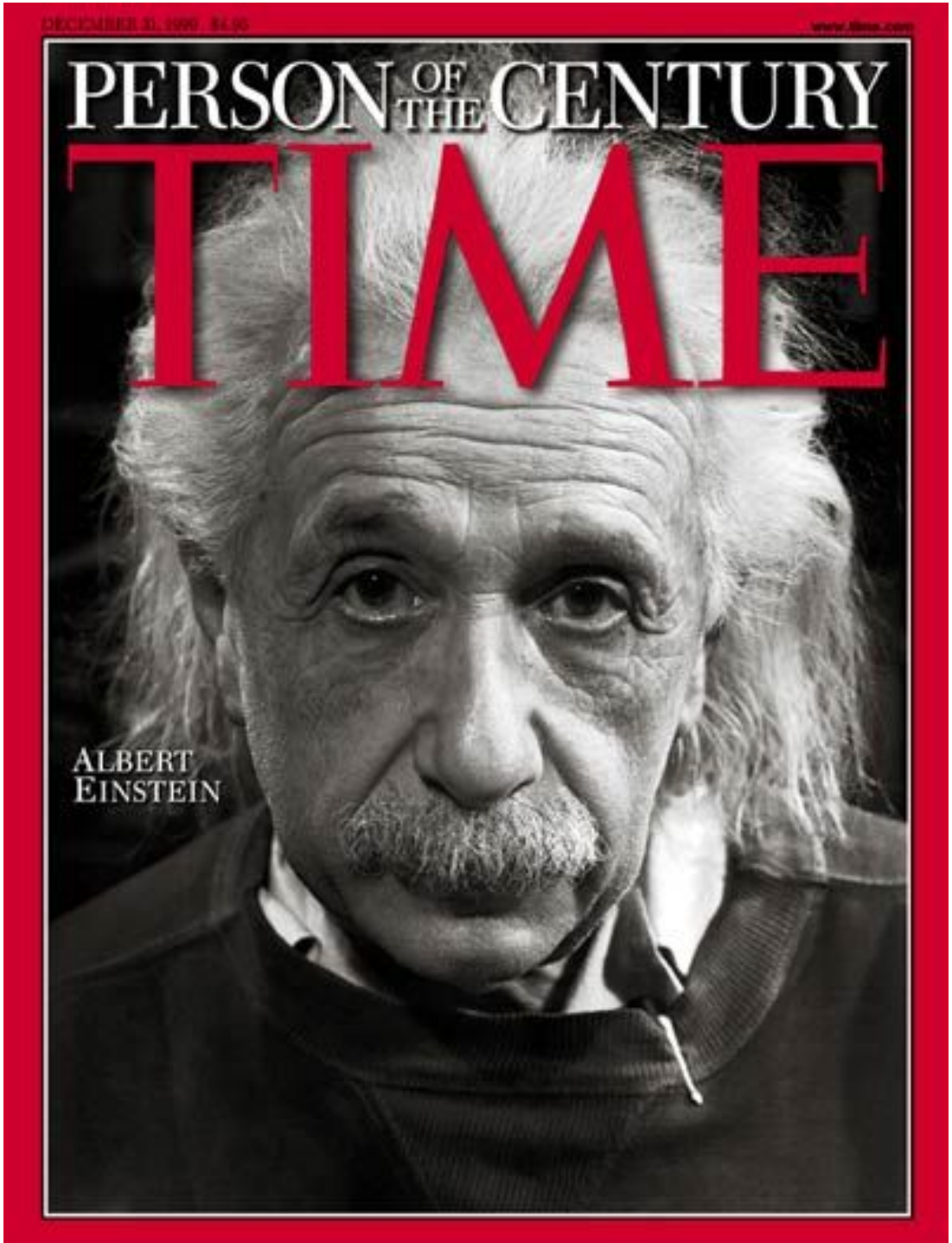
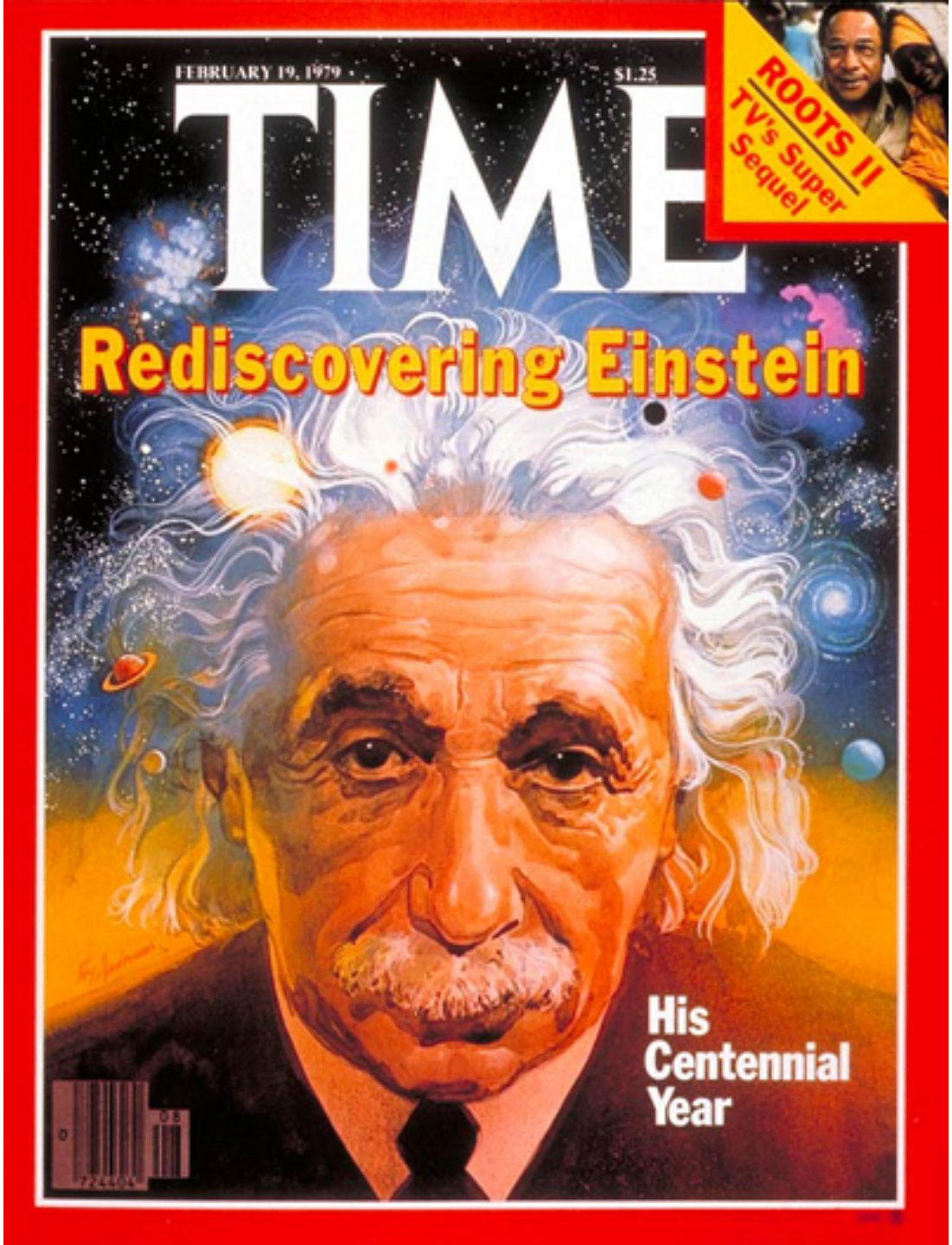
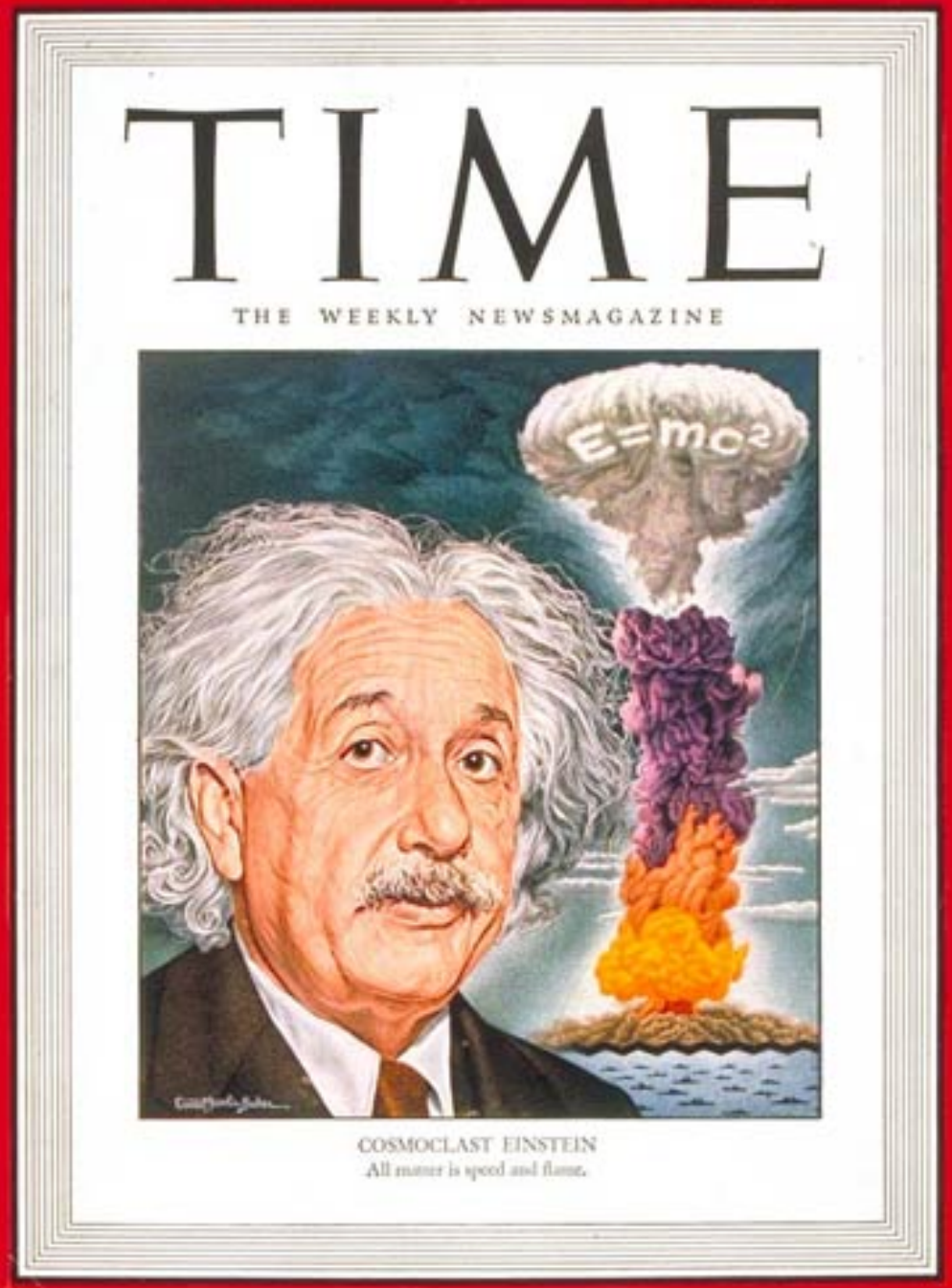
Halfway around the world, the young traveler Charles Darwin arrived at foreboding towering volcanoes, the “Enchanted Islands.” Their dark jagged terrain held swarms of hideous reptiles, “imps of darkness,” and tame birds. Yet Darwin found no frogs or toads on the islands. He found *only* the kinds of animals that could cross the salty waters from the continent. All resembled American species, but oddly distinct. He later concluded that such island species descended from *colonists*, but somehow evolved.



Dec.31
1999

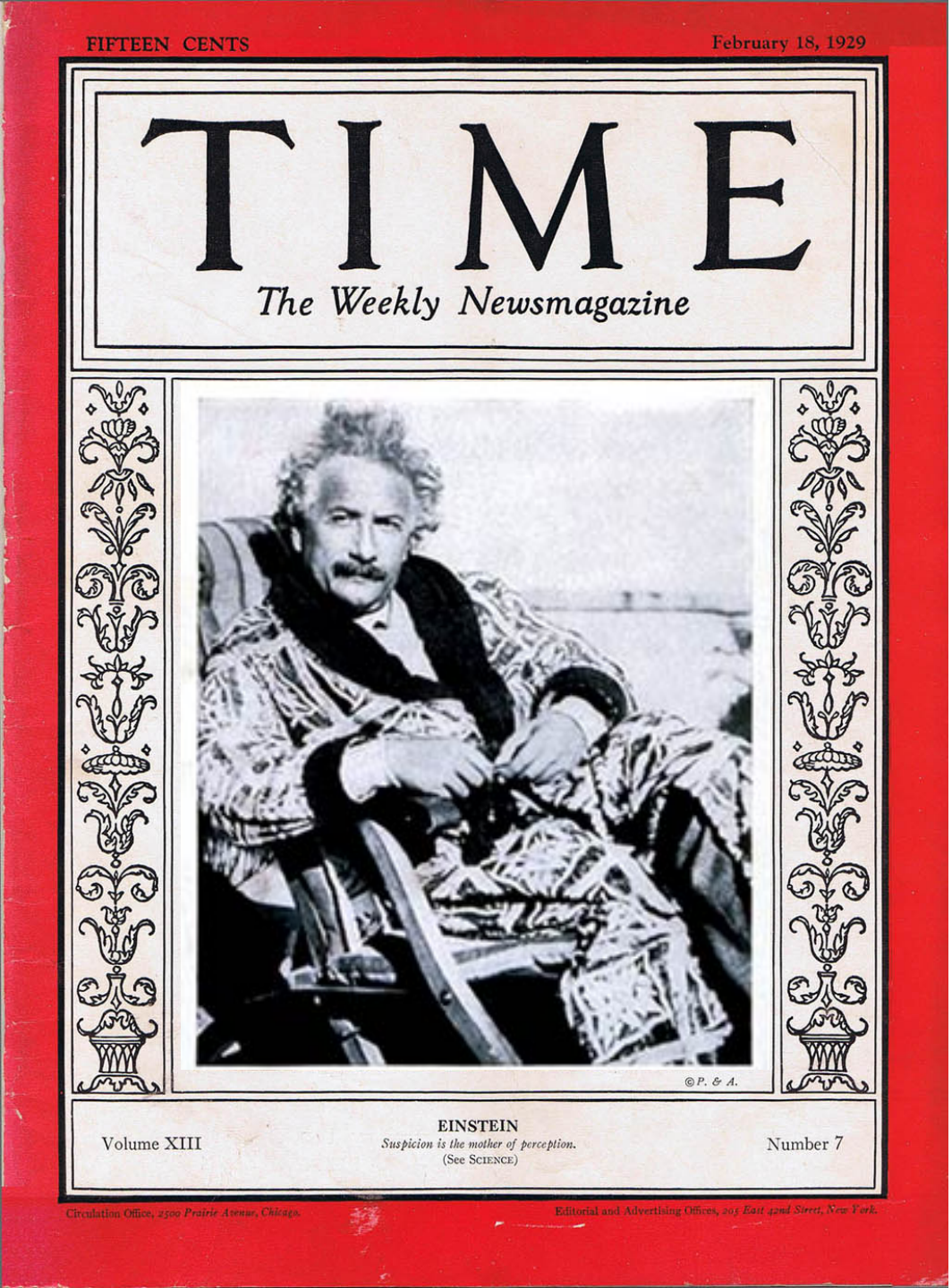

FEBRUARY 19, 1979
$1.25
TIME
ROOTS II
TV's Super Sequel
Rediscovering Einstein
His Centennial Year

1979



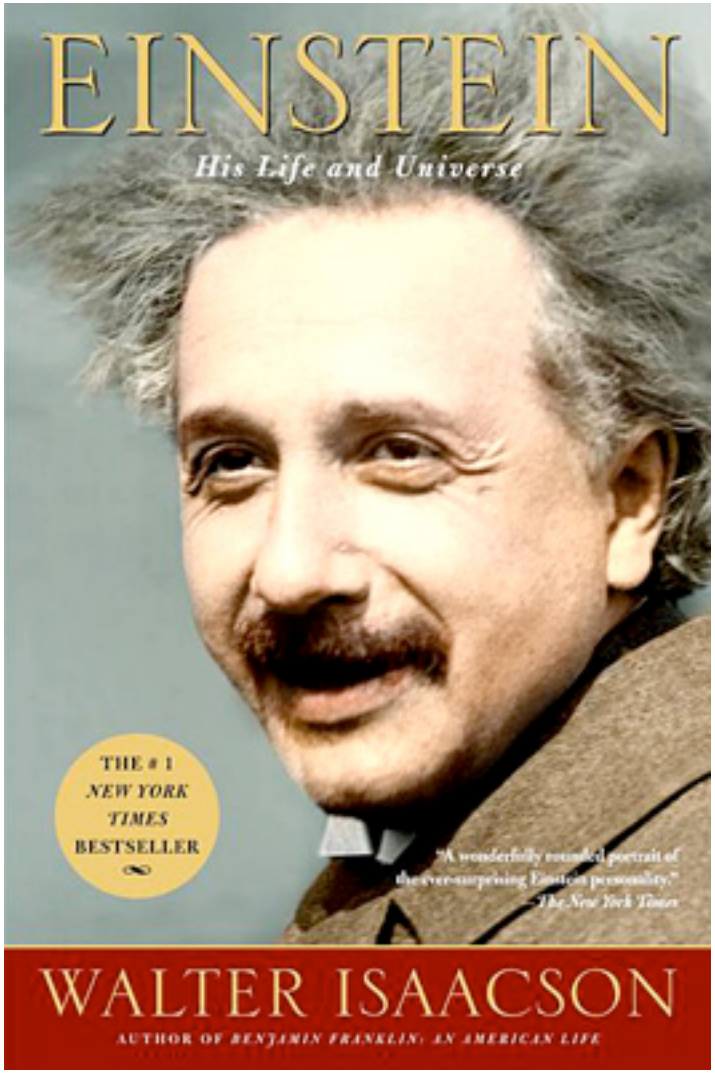
"Cosmoclast Einstein.
All matter
is speed and flame."
July 1, 1946

"Einstein … circuitously groping toward unity."
April 4, 1938



"Suspicion is the mother of perception."
February 18, 1929

New York Times Magazine, 1979



#1
New York Times
Bestseller, 2007

Einstein, Zurich, 1898


EINSTEIN HAUS
STUCKI
STUCKI
STUCKI


Kasse
Caisse
Cash Desk


RISTORANT

ANNALEN
DER
PHYSIK.

BEGRÜNDET UND FORTGEFÜHRT DURCH

F. A. C. GREN, L. W. GILBERT, J. C. POGGENDORFF, G. UND E. WIEDEMANN.

VIERTE FOLGE.

BAND 17. HEFT 1.

DER GANZEN REIHE 322. BANDES 1. HEFT.

UNTER MITWIRKUNG

DER DEUTSCHEN PHYSIKALISCHEN GESELLSCHAFT

UND INSBESONDERE VON

M. PLANCK

HERAUSGEGEBEN VON

PAUL DRUDE.

MIT EINER TAFEL.

LEIPZIG, 1905.
VERLAG VON JOHANN AMBROSIUS BARTH.
ROSSPLATZ 17.

Einstein's Theory Relativity
is based on

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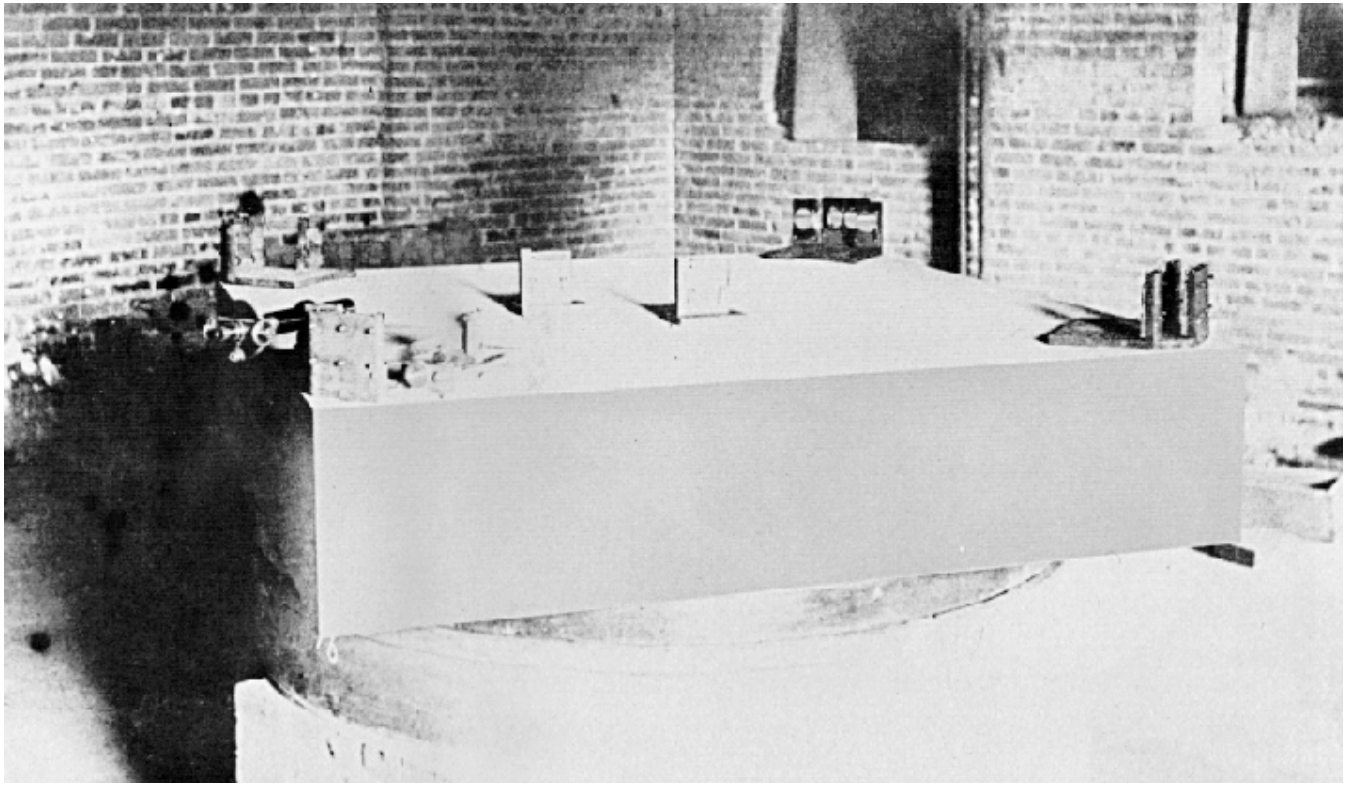
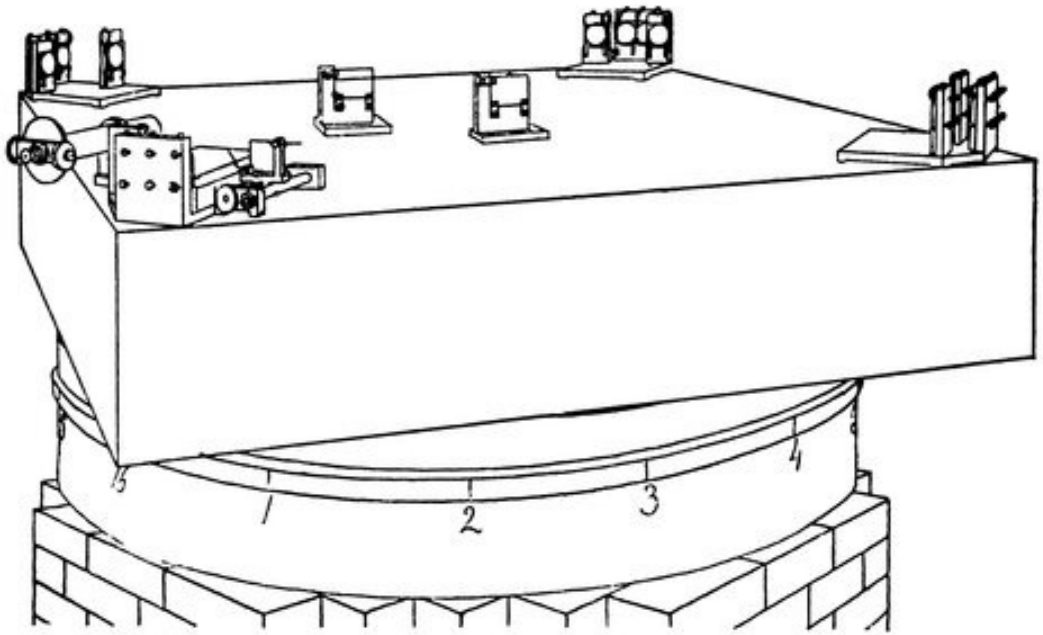
In some books it is
an experimental fact

In other books it is
a postulate



Michelson Morley
experiment, 1887

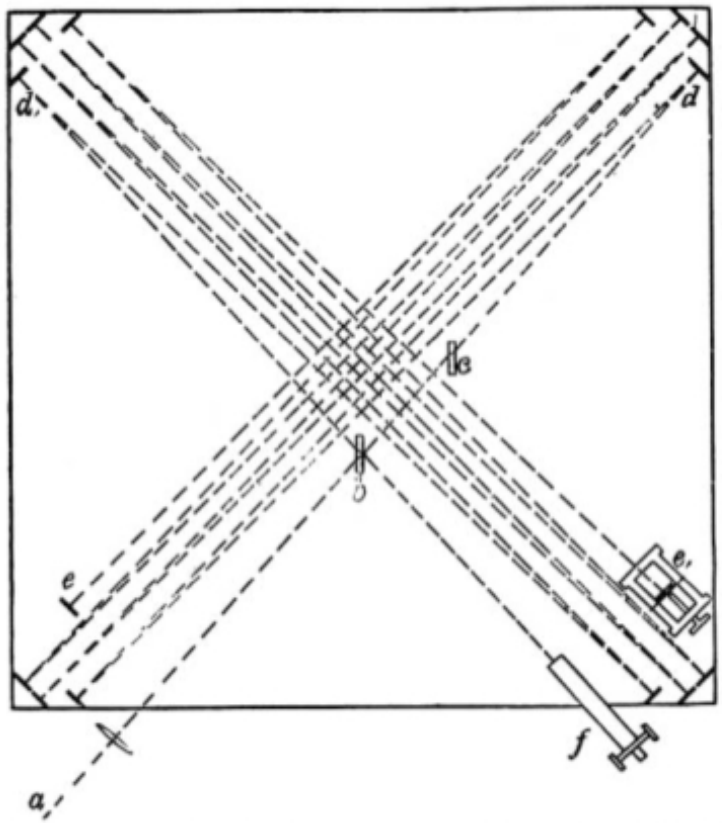


Michelson Morley
experiment, 1887

their surfaces measured 5·0 by 7·5 centimeters. The second of these was placed in the path of one of the pencils to compensate for the passage of the other through the same thickness of glass. The whole of the optical portion of the apparatus was kept covered with a wooden cover to prevent air currents and rapid changes of temperature.

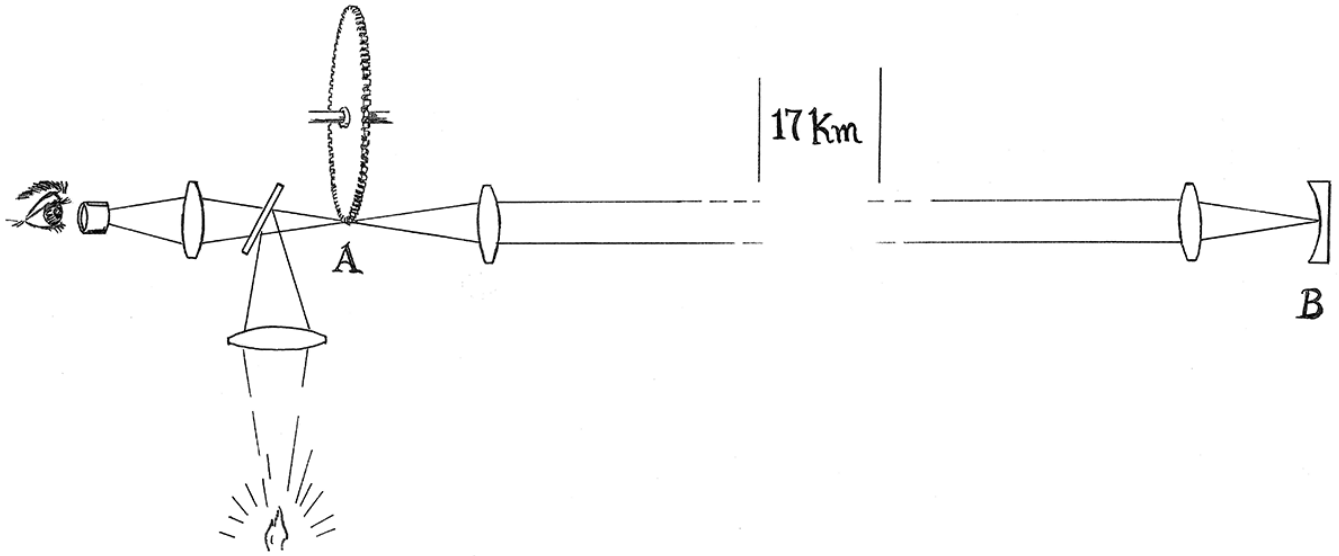
The adjustment was effected as follows: The mirrors having been adjusted by screws in the castings which held the

4.

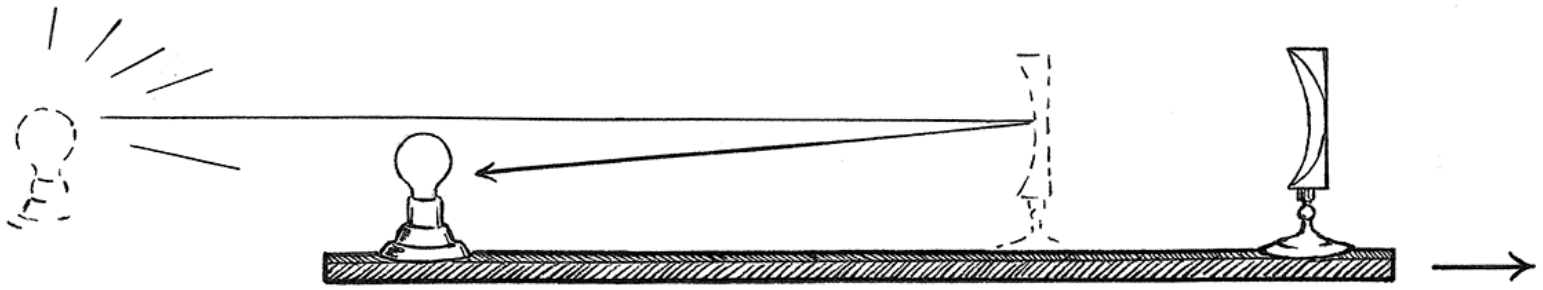


mirrors, against which they were pressed by springs, till light from both pencils could be seen in the telescope, the lengths of the two paths were measured by a light wooden rod reaching diagonally from mirror to mirror, the distance being read from a small steel scale to tenths of millimeters. The difference in the lengths of the two paths was then annulled by moving the mirror e_1. This mirror had three adjustments; it had an adjustment in altitude and one in azimuth, like all the other mirrors,

Michelson Morley experiment, 1887



Fizeau on the speed of light
1849



Über die spezielle und die allgemeine Relativitätstheorie

(Gemeinverständlich)

Von

A. EINSTEIN

Mit 3 Figuren

Braunschweig
Druck und Verlag von Friedr. Vieweg & Sohn
1917

ANNALEN
DER
PHYSIK.

BEGRÜNDET UND FORTGEFÜHRT DURCH

F. A. C. GREN, L. W. GILBERT, J. C. POGGENDORFF, G. UND E. WIEDEMANN.

VIERTE FOLGE.

BAND 17. HEFT 1.

DER GANZEN REIHE 322. BANDES 1. HEFT.

UNTER MITWIRKUNG

DER DEUTSCHEN PHYSIKALISCHEN GESELLSCHAFT

UND INSBESONDERE VON

M. PLANCK

HERAUSGEGEBEN VON

PAUL DRUDE.

MIT EINER TAFEL.

LEIPZIG, 1905.
VERLAG VON JOHANN AMBROSIUS BARTH.
ROSSPLATZ 17.

3. *Zur Elektrodynamik bewegter Körper; von A. Einstein.*

Daß die Elektrodynamik Maxwells — wie dieselbe gegenwärtig aufgefaßt zu werden pflegt — in ihrer Anwendung auf bewegte Körper zu Asymmetrien führt, welche den Phänomenen nicht anzuhaften scheinen, ist bekannt. Man denke z. B. an die elektrodynamische Wechselwirkung zwischen einem Magneten und einem Leiter. Das beobachtbare Phänomen hängt hier nur ab von der Relativbewegung von Leiter und Magnet, während nach der üblichen Auffassung die beiden Fälle, daß der eine oder der andere dieser Körper der bewegte sei, streng voneinander zu trennen sind. Bewegt sich nämlich der Magnet und ruht der Leiter, so entsteht in der Umgebung des Magneten ein elektrisches Feld von gewissem Energiewerte, welches an den Orten, wo sich Teile des Leiters befinden, einen Strom erzeugt. Ruht aber der Magnet und bewegt sich der Leiter, so entsteht in der Umgebung des Magneten kein elektrisches Feld, dagegen im Leiter eine elektromotorische Kraft, welcher an sich keine Energie entspricht, die aber — Gleichheit der Relativbewegung bei den beiden ins Auge gefaßten Fällen vorausgesetzt — zu elektrischen Strömen von derselben Größe und demselben Verlaufe Veranlassung gibt, wie im ersten Falle die elektrischen Kräfte.

Beispiele ähnlicher Art, sowie die mißlungenen Versuche, eine Bewegung der Erde relativ zum „Lichtmedium“ zu konstatieren, führen zu der Vermutung, daß dem Begriffe der absoluten Ruhe nicht nur in der Mechanik, sondern auch in der Elektrodynamik keine Eigenschaften der Erscheinungen entsprechen, sondern daß vielmehr für alle Koordinatensysteme, für welche die mechanischen Gleichungen gelten, auch die gleichen elektrodynamischen und optischen Gesetze gelten, wie dies für die Größen erster Ordnung bereits erwiesen ist. Wir wollen diese Vermutung (deren Inhalt im folgenden „Prinzip der Relativität“ genannt werden wird) zur Voraussetzung erheben und außerdem die mit ihm nur scheinbar unverträgliche

Wir haben zu berücksichtigen, daß alle unsere Urteile, in welchen die Zeit eine Rolle spielt, immer Urteile über *gleichzeitige Ereignisse* sind. Wenn ich z. B. sage: „Jener Zug kommt hier um 7 Uhr an," so heißt dies etwa: „Das Zeigen des kleinen Zeigers meiner Uhr auf 7 und das Ankommen des Zuges sind gleichzeitige Ereignisse."[1])

Es könnte scheinen, daß alle die Definition der „Zeit" betreffenden Schwierigkeiten dadurch überwunden werden könnten, daß ich an Stelle der „Zeit" die „Stellung des kleinen Zeigers meiner Uhr" setze. Eine solche Definition genügt in der Tat

a train,
clocks,
and
synchronization

B durch einen in B befindlichen Beobachter möglich. Es ist aber ohne weitere Festsetzung nicht möglich, ein Ereignis in A mit einem Ereignis in B zeitlich zu vergleichen; wir haben bisher nur eine „A-Zeit" und eine „B-Zeit", aber keine für A und B gemeinsame „Zeit" definiert. Die letztere Zeit kann nun definiert werden, indem man *durch Definition* festsetzt, daß die „Zeit", welche das Licht braucht, um von A nach B zu gelangen, gleich ist der „Zeit", welche es braucht, um von B nach A zu gelangen. Es gehe nämlich ein Lichtstrahl zur „A-Zeit" t_A von A nach B ab, werde zur „B-Zeit" t_B in B gegen A zu reflektiert und gelange zur „A-Zeit" t'_A nach A zurück. Die beiden Uhren laufen definitionsgemäß synchron, wenn

$$t_B - t_A = t'_A - t_B.$$

Wir nehmen an, daß diese Definition des Synchronismus in widerspruchsfreier Weise möglich sei, und zwar für beliebig viele Punkte, daß also allgemein die Beziehungen gelten:

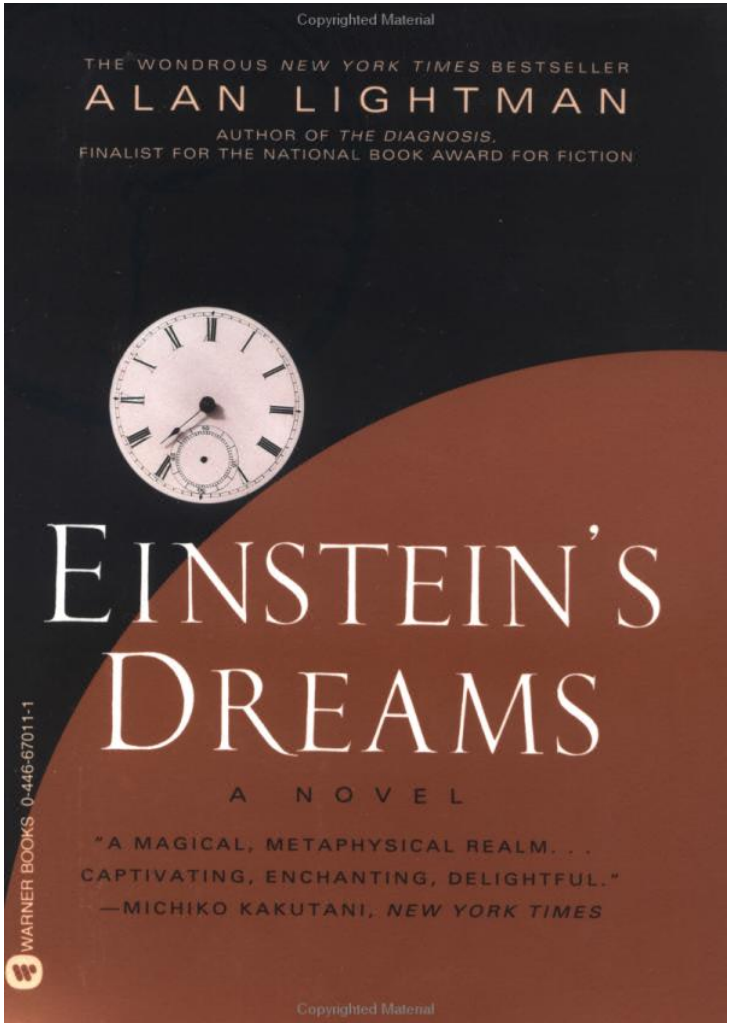
1. Wenn die Uhr in B synchron mit der Uhr in A läuft, so läuft die Uhr in A synchron mit der Uhr in B.

2. Wenn die Uhr in A sowohl mit der Uhr in B als auch

2331 Bern. Marktgasse mit Zeitglockenturm.


Apotheke


WALO



While theorizing about the nature of time with his friend Besso, Einstein dreamed of clock towers.

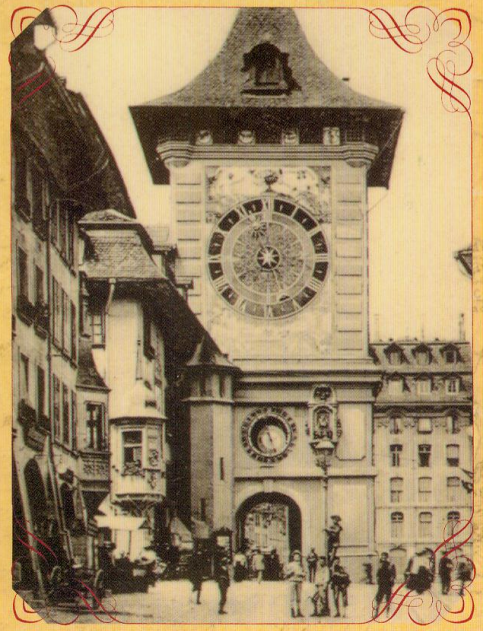
(fiction)

1993

In 1905,
the clock towers
of Bern
inspired Einstein
to think of
the relativity
of time.

Einstein's Clocks, Poincaré's Maps

Empires of Time



PETER GALISON

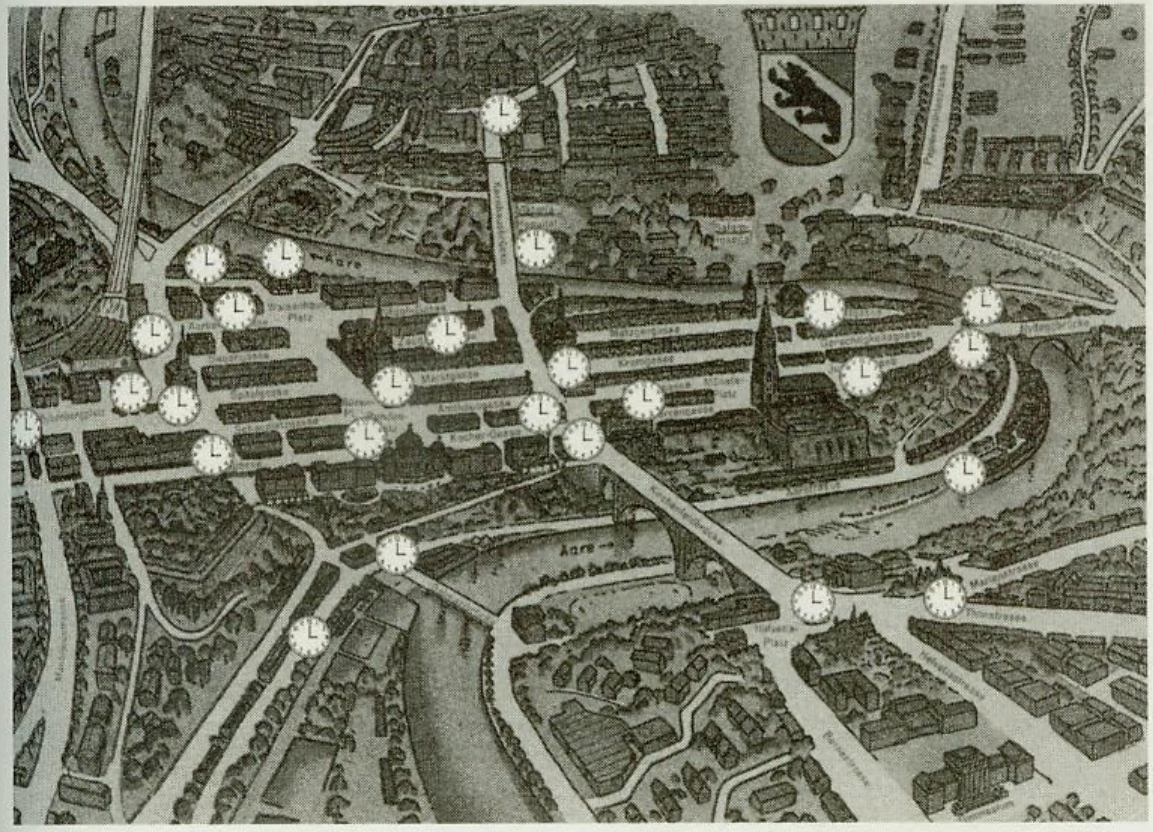


Figure 5.4 ***Bern's Electrical Clock Network (circa 1905).*** *Coordinated, electrical clocks were a matter of practical import and cultural pride. By 1905, they were a prominent piece of the modern urban landscape throughout the city of Bern.* SOURCE: BERN CITY MAP FROM THE HARVARD MAP COLLECTION; CLOCK LOCATIONS SHOWN USING DATA FROM MESSERLI, *GLEICHMÄSSIG* (1995).


valter
valter
valter


Der Bund

est in sensitive electromechanical devices that would bridge worlds of electricity and mechanics. Electromagnetic clock coordination proposals were right up his alley—they offered ways to transform small electrical currents into high-precision rotary movements.

Time coordination patents continued to pour into the office. On 25 April 1905 at 6:15 P.M., for example, the office recorded the arrival of a patent application for an electromagnetically controlled pendulum that would take a signal and bring a distant pendulum clock into accord.[65] All such inventions required documentation, including a model, specific drawings, and properly prepared descriptions and claims. Evaluating them was painstaking and often lasted for months.

Sometime in the middle of May 1905 (and we note that Einstein moved outside Bern's zone of unified time on May 15th), he and his closest friend, Michele Besso, had cornered the electromagnetism problem from every angle. "Then," Einstein recalled, "suddenly I understood where the key to this problem lay." He skipped his greetings the next day when he met Besso: ""Thank you. I've completely solved the problem.' An analysis of the concept of time was my solution. Time cannot be absolutely defined, and there is an inseparable relation between time and signal velocity."[66] Pointing up at a Bern clock tower—one of the famous Bern synchronized clocks—and then to the one and only clock tower in nearby Muri (the traditional aristocratic annex of Bern not yet linked to Bern's Normaluhr), Einstein laid out for his friend his synchronization of clocks.[67]

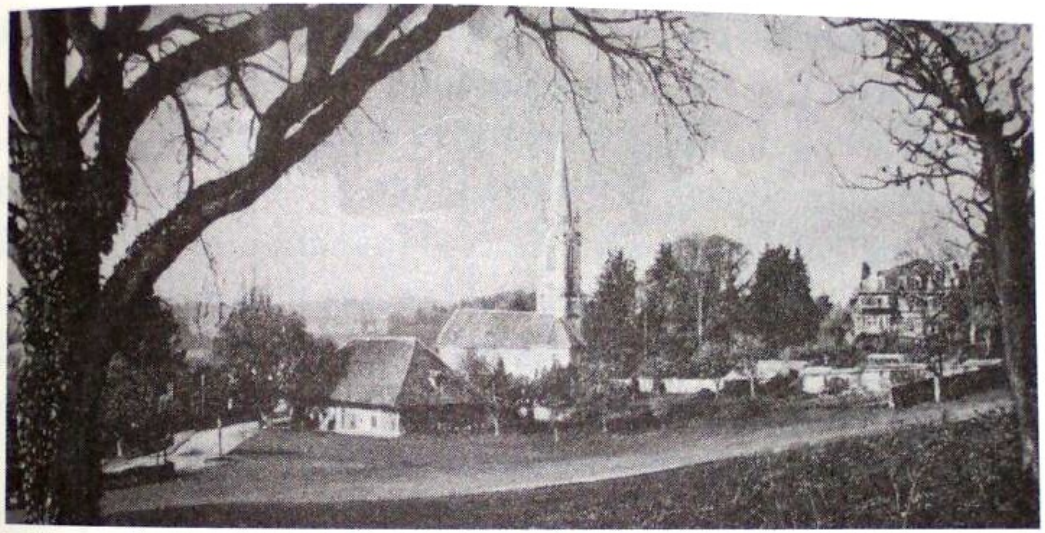


Figure 5.8 Muri Clocktower (circa 1900). *When Einstein gestured toward Muri's only clock tower as he explained to Besso his new time-coordination scheme, this is the structure to which he pointed.* SOURCE: GEMEINDESCHREIBEREI MURI BEI BERN.

Figure 5.7 Bern-Muri Map. *Michele Besso recalled that when Einstein excitedly told him of his realization that time had to be defined by signal exchange, he pointed to one clock tower in old Bern and to another (the only one) in the nearby town of Muri. Since it is the only vantage point from which both might have been visible, Besso and Einstein must have been standing on the hill shown to the northeast of downtown Bern.* SOURCE: MODIFIED FROM SKORPION-VERLAG.

The New York Times

August 17, 2003

Book Review

Resetting the Universe

In 'Einstein's Clocks, Poincaré's Maps,' Peter Galison pursues the masters who rearranged time and distance in the science of the early 20th century.

Reviewed by William R. Everdell **9**

Garrison Keillor's novel about fame and The New Yorker. *Reviewed by Carl Hiaasen.* **10**

Robert Gottlieb on A. Scott Berg and the friendships of Katharine Hepburn. **13**

The New York Times

Time. Space.

Continued from preceding page

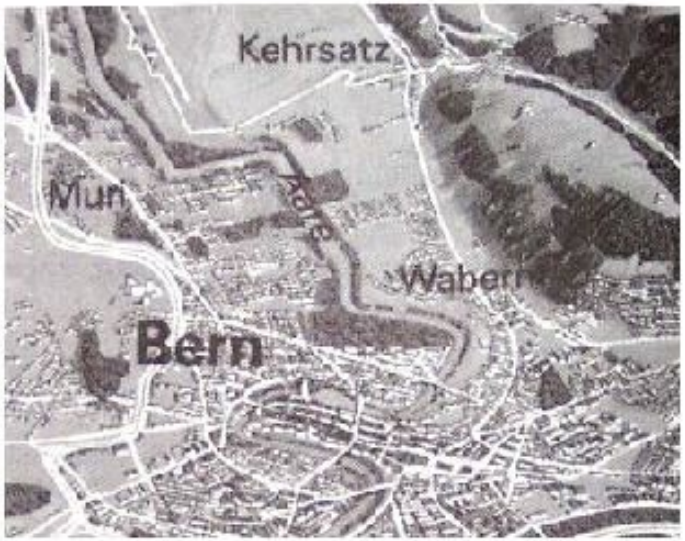
tronic synchronization of clocks so that busy bourgeois would always make their rendezvous, trains would never collide and a nation's entire army could mass in a matter of hours on any threatened frontier.

IN May 1905, on a hill from which he and his friend Michele Besso could see both the electrically synchronized clocks of Bern and the as yet uncoordinated clock in the tower of suburban Muri, Einstein realized in a flash that the only thing that would not change in empty space was a particular speed. Not a time, because time was undeterminable except in relation to another time, and not a rigid three-dimensional object or frame of reference either, because that would only be "unchangeable" in its own boundaries, but the unique speed of light in empty space, the top speed possible for the transmission of information about clock times and changes.

Time would always be relative to

MAPQUEST.

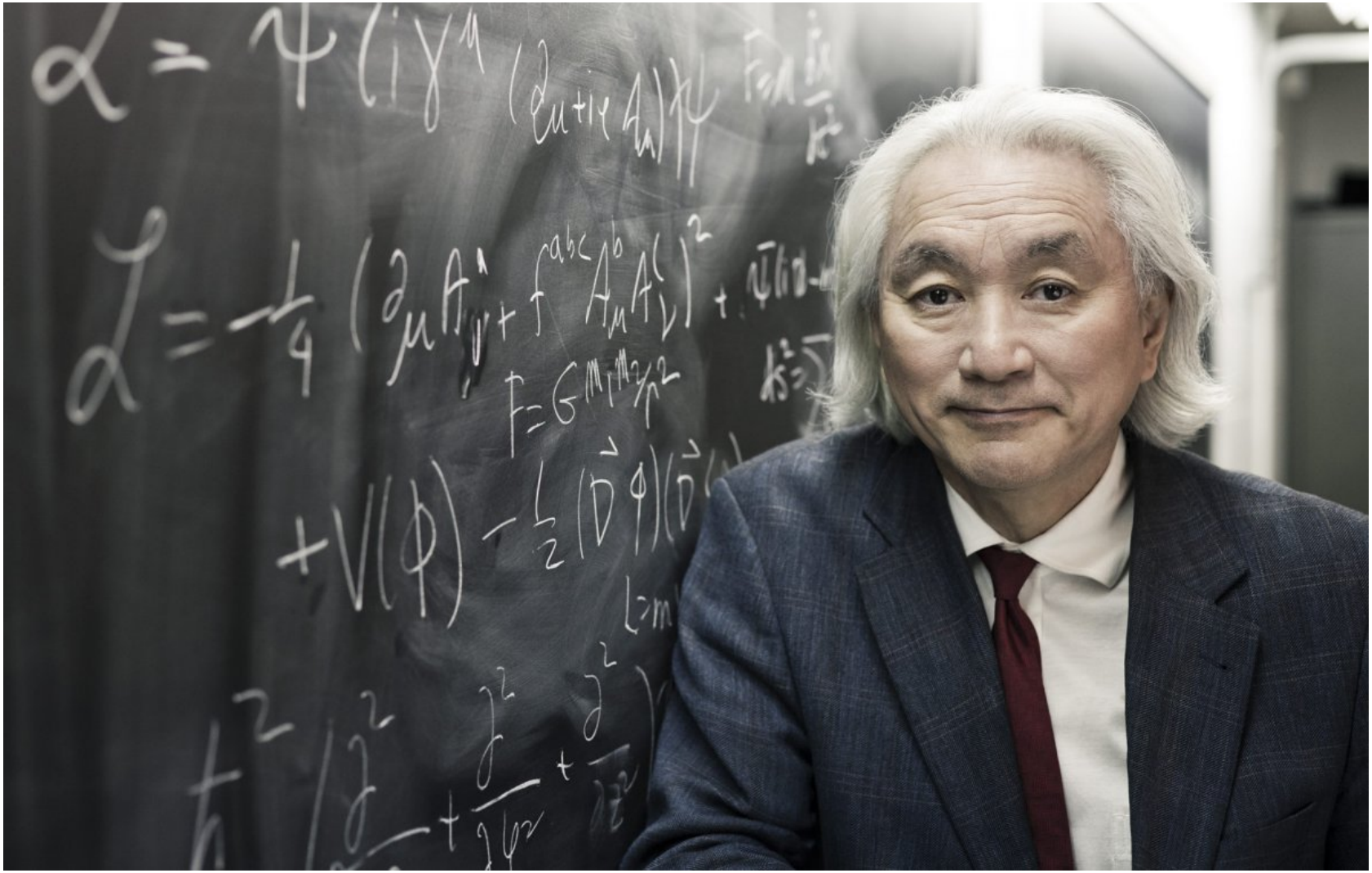
EINSTEIN'S CLOCKS, POINCARÉ'S MAPS



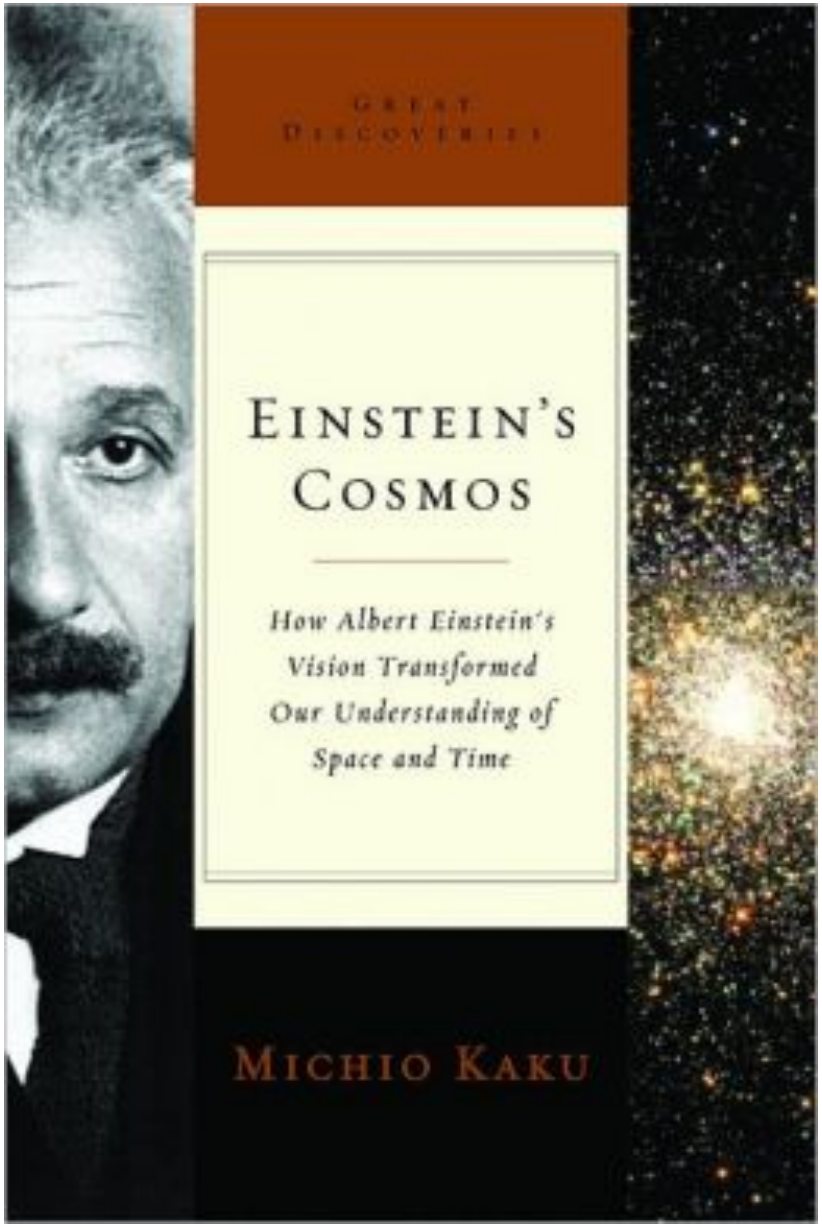
Josef Sauter, 1955:

“to pin down the ideas,” he told me,
“let’s suppose that one of the clocks
is atop a tower at Bern
and the other on a tower at Muri”

1902-1909	Albert Einstein worked at the Swiss patent office. From 1904-1905, he walked by the Zytglogge clock tower on his way to work.	
1955	Josef Sauter, a coworker, recalled words from 1905	Einstein once illustrated his definition of synchrony: "to pin down the ideas, he told me, let's suppose that one of the clocks is atop a tower at Bern and the other on a tower at Muri."
1974	Max Flückiger, historian	It is interesting that Sauter mentioned the bell towers. Einstein sometimes visited his friends and colleagues in Bern and Muri.
1993	Albrecht Fölsing, biographer	"He was observed gesticulating to friends and colleagues as he pointed to one of Bern's bell towers and then to one in the neighboring village of Muri. Michele Besso was the first person and Josef Sauter the second to whom he explained in this manner that the synchronization of spatially separated clocks..."
1993	Alan Lightman, science writer	While theorizing about the nature of time with his friend Besso, Einstein dreamed of clock towers. (fictional story)
1999	Steven Pinker, psychologist	"from imagining himself riding on a beam of light and looking back at a seemingly frozen clock tower, he developed the theory of special relativity."
2000	Denis Overbye, science writer	"It would be pretty to think" that maybe Einstein's breakthrough happened as he and Besso walked under the great clock tower.
2001	Arthur I. Miller, historian	Einstein often spoke with coworkers about the synchronization of clocks.
2003	Peter Galison, historian	Standing on a hill northeast of downtown Bern, Einstein excitedly gestured to clock towers of Bern and Muri as he explained to Besso that time should be defined by exchanging signals.
2003	William Everdell, history teacher and author	"In May 1905, on a hill from which he and his friend Michele Besso could see both the electrically synchronized clocks of Bern and the as yet uncoordinated clock tower of suburban Muri, Einstein realized in a flash that...."
2005	Michio Kaku, physicist	Einstein "imagined what would happen if his street car raced away from that clock tower at the speed of light."
2007	Walter Isaacson, biographer	The synchronized clocks of Bern were not synchronized with the steeple clock visible in the neighboring village of Muni.
2008	Hans Ohanian, physicist	Einstein "reviewed patent applications for electromagnetic devices used for the operation of citywide networks of synchronized clocks." He pointed at a clock tower in Bern and to another in Muri to exemplify to Besso his crucial idea about synchronizing clocks.

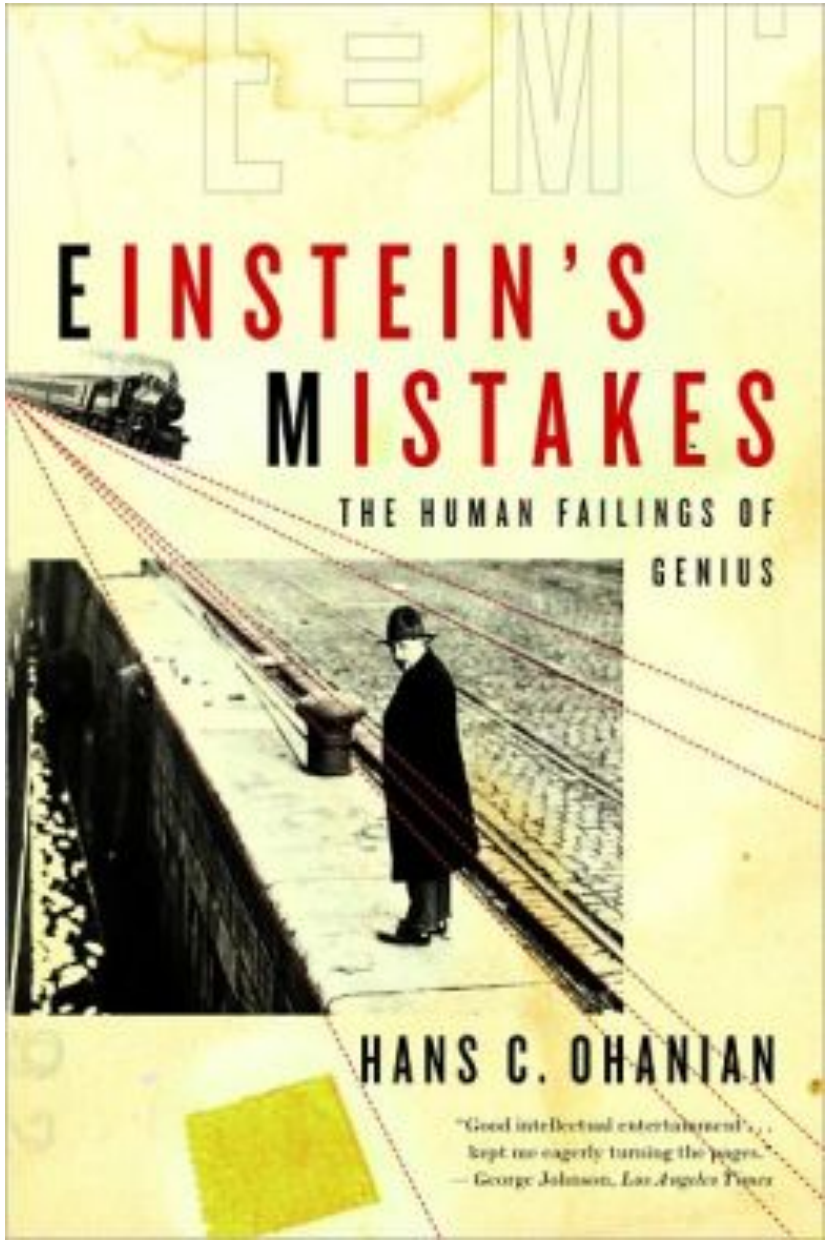


Michio Kaku, C.U.N.Y.



Einstein "imagined what would happen if his street car raced away from that clock tower at the speed of light."

2005



Einstein "reviewed patent applications for electromagnetic devices used for the operation of citywide networks of synchronized clocks."
He pointed at a clock tower in Bern and to another in Muri to exemplify to Besso his crucial idea about synchronizing clocks.

2008

David Hume

A Treatise of Human Nature

(1739-40)

A

TREATISE

OF

Human Nature:

BEING

An ATTEMPT to introduce the experimental Method of Reaſoning

INTO

MORAL SUBJECTS.

by David Hume Esqr.

Rara temporum felicitas, ubi ſentire, quæ velis; & quæ ſentias, dicere licet. TACIT.

VOL. I.

OF THE

UNDERSTANDING.

LONDON:

Printed for JOHN NOON, at the *White-Hart*, near *Mercer's-Chapel*, in *Cheapſide*.

MDCCXXXIX.

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trust secondary sources!

Readers should *not*
trust secondary sources!

There is a tension between
scientific analysis
and the authority of books.

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There is a tension between
scientific analysis
and the authority of books.

To better understand the sciences,
we need to study
the history of our mistakes.

Martínez

KINEMATICS

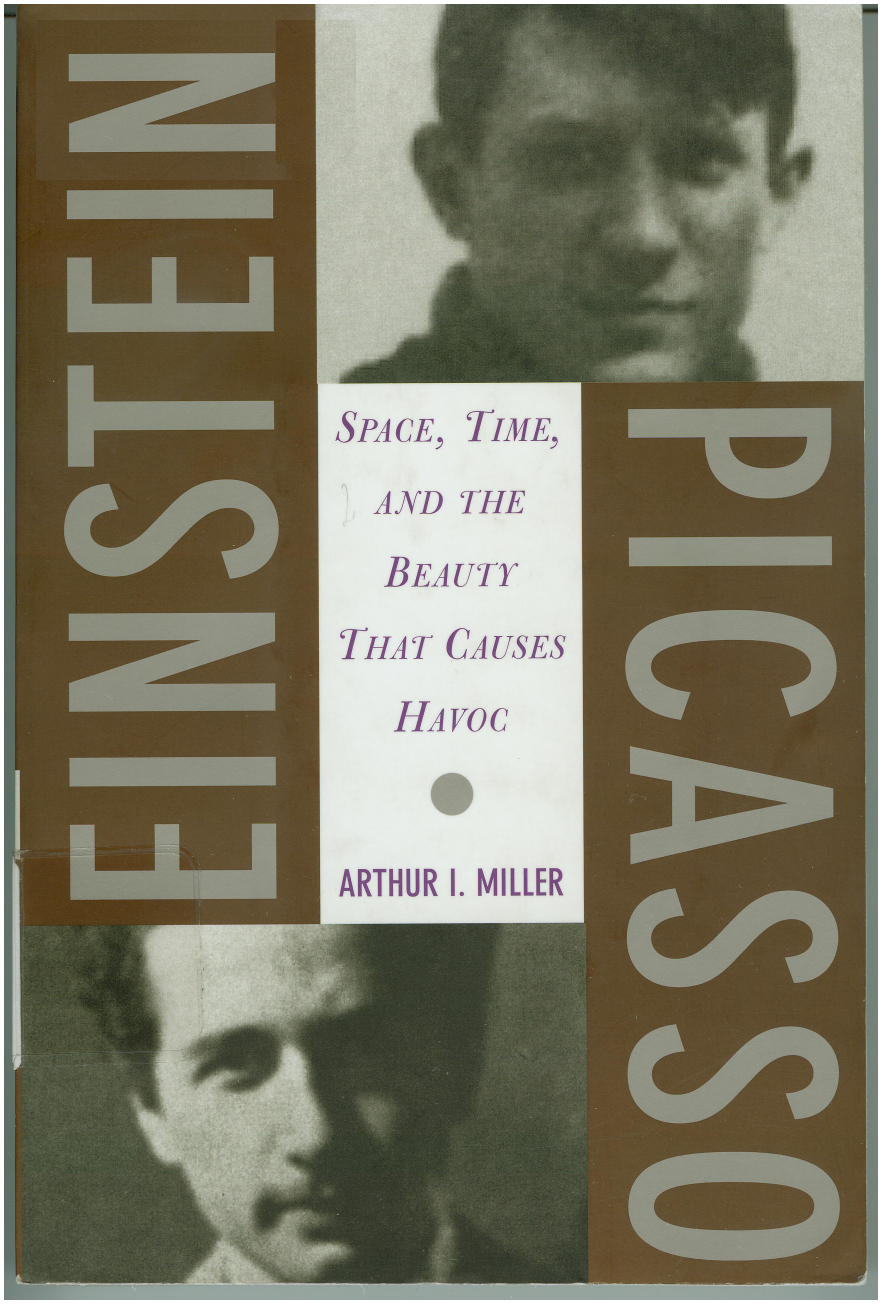
The Lost Origins of Einstein's Relativity

JOHNS HOPKINS

KINEMATICS

The Lost Origins of Einstein's Relativity

Alberto A. Martínez


EINSTEIN
PICASSO
SPACE, TIME, AND THE BEAUTY THAT CAUSES HAVOC
ARTHUR I. MILLER