MICHAEL A. SEEDS
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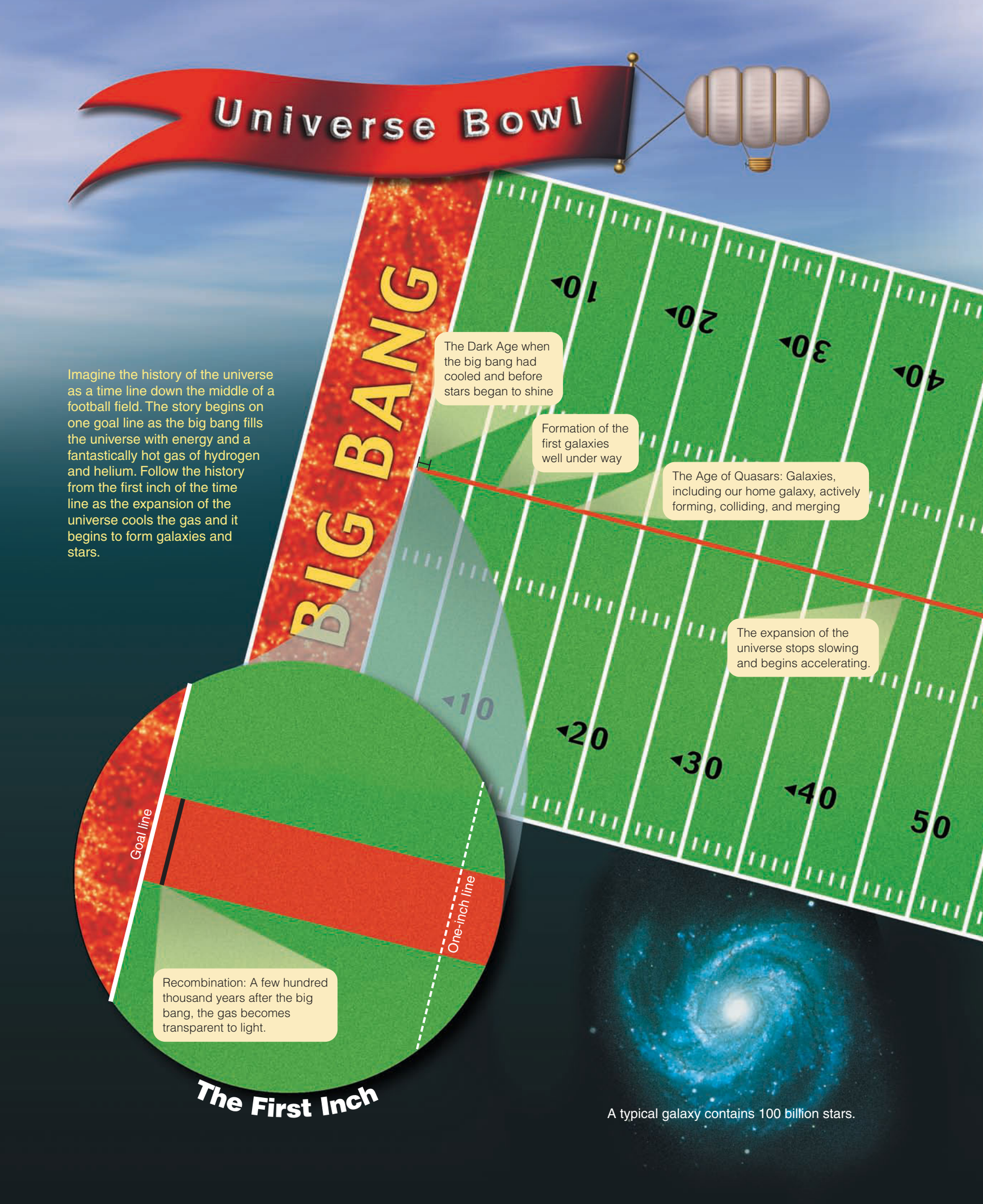
HORIZONS

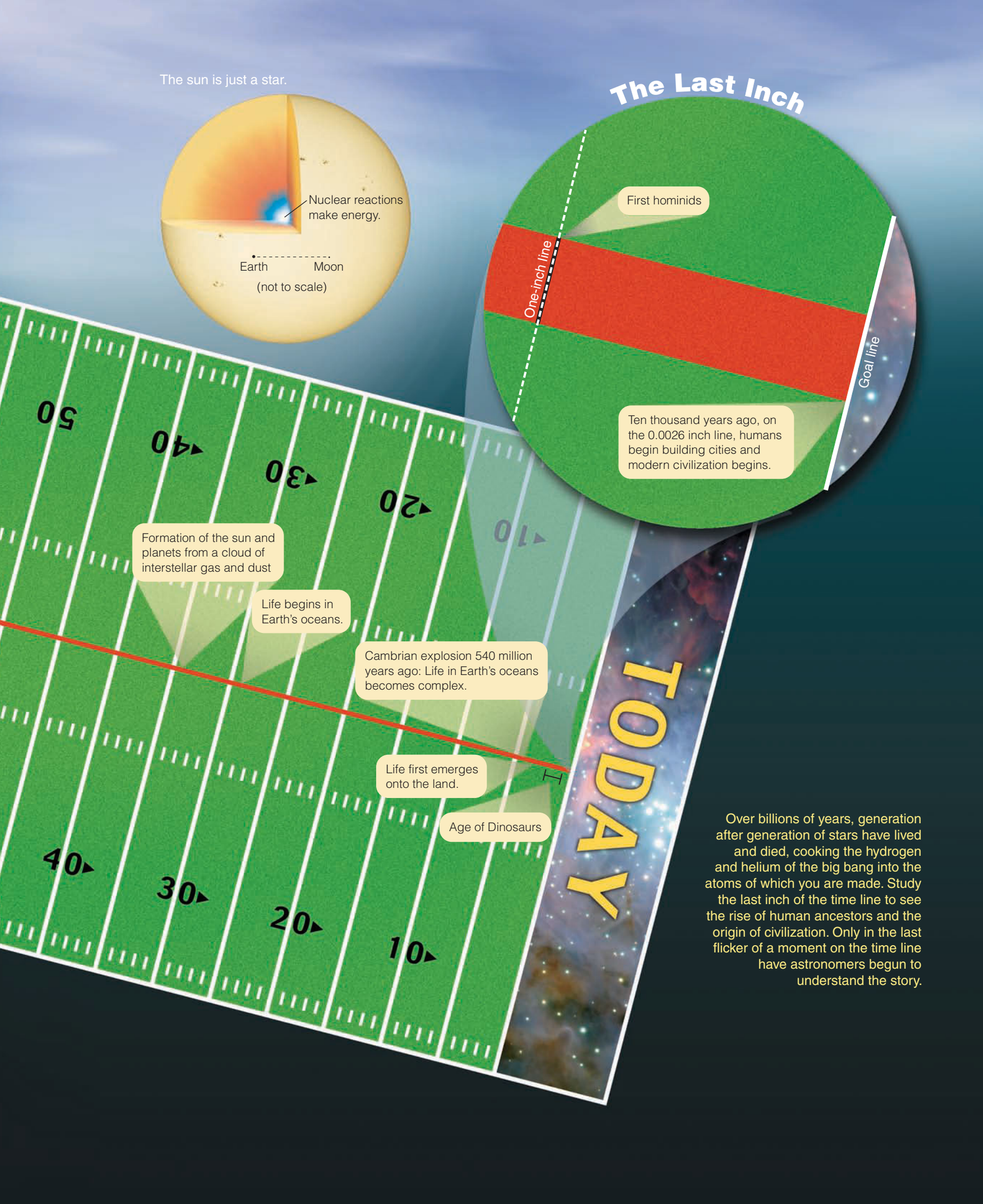
EXPLORING THE UNIVERSE | 11E

INTERSTELLAR CLOUDS AND **ORGANIC MOLECULES**

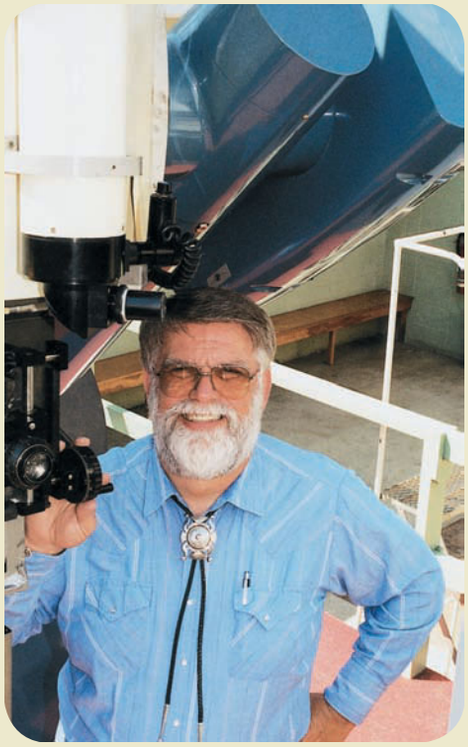
GAMMA RAY BURSTS FROM THE FIRST STARS

DIGGING FOR **WATER ON MARS**


Universe Bowl
BIG BANG
Imagine the history of the universe as a time line down the middle of a football field. The story begins on one goal line as the big bang fills the universe with energy and a fantastically hot gas of hydrogen and helium. Follow the history from the first inch of the time line as the expansion of the universe cools the gas and it begins to form galaxies and stars.
The Dark Age when the big bang had cooled and before stars began to shine
Formation of the first galaxies well under way
The Age of Quasars: Galaxies, including our home galaxy, actively forming, colliding, and merging
The expansion of the universe stops slowing and begins accelerating.
10
20
30
40
50
Goal line
One-inch line
Recombination: A few hundred thousand years after the big bang, the gas becomes transparent to light.
The First Inch
A typical galaxy contains 100 billion stars.


The sun is just a star.
Nuclear reactions make energy.
Earth
Moon
(not to scale)
The Last Inch
First hominids
One-inch line
Goal line
Ten thousand years ago, on the 0.0026 inch line, humans begin building cities and modern civilization begins.
Formation of the sun and planets from a cloud of interstellar gas and dust
Life begins in Earth's oceans.
Cambrian explosion 540 million years ago: Life in Earth's oceans becomes complex.
Life first emerges onto the land.
Age of Dinosaurs
TODAY
Over billions of years, generation after generation of stars have lived and died, cooking the hydrogen and helium of the big bang into the atoms of which you are made. Study the last inch of the time line to see the rise of human ancestors and the origin of civilization. Only in the last flicker of a moment on the time line have astronomers begun to understand the story.

About the Authors



Mike Seeds has been a Professor of Physics and Astronomy at Franklin and Marshall College in Lancaster, Pennsylvania, since 1970. In 1989 he received F&M College's Lindback Award for Distinguished Teaching. Mike's love for the history of astronomy led him to create upper-level courses on "Archaeoastronomy" and "Changing Concepts of the Universe." His research interests focus on variable stars and the automation of astronomical telescopes. Mike is the author of *Horizons: Exploring the Universe,* Eleventh Edition (2010); *Astronomy: The Solar System and Beyond,* Sixth Edition (2010); *Foundations of Astronomy,* Tenth Edition (2008); and *Perspectives on Astronomy* (2008), all published by Brooks/Cole. He was Senior Consultant for creation of the 20-episode telecourse accompanying his book *Horizons: Exploring the Universe.*

Dana Backman taught in the physics and astronomy department at Franklin and Marshall College in Lancaster, Pennsylvania, from 1991 until 2003. He invented and taught a course titled "Life in the Universe" in F&M's interdisciplinary Foundations program. Dana now teaches introductory astronomy, astrobiology, and cosmology courses in Stanford University's Continuing Studies Program. His research interests focus on infrared observations of planet formation, models of debris disks around nearby stars, and evolution of the solar system's Kuiper Belt. Dana is the author of the first edition of *Perspectives on Astronomy* (2008); *Horizons: Exploring the Universe,* Eleventh Edition (2010); and *Astronomy: The Solar System and Beyond,* Sixth Edition (2010), all published by Brooks/Cole. He is with the SETI Institute in Mountain View, California, in charge of the education and public outreach program for SOFIA (Stratospheric Observatory for Infrared Astronomy) at NASA's Ames Research Center.