

Astronomy and Astrophysics in the New Millennium (2001)

(<http://books.nap.edu/openbook/0309070317/html/index.html>)

- Survey the universe and its constituents, including galaxies as they evolve through cosmic time, stars and planets as they form out of collapsing interstellar clouds in our galaxy, interstellar and intergalactic gas as it accumulates the elements created in stars and supernovae, and the mysterious dark matter and perhaps dark energy that so strongly influence the large-scale structure and dynamics of the universe.
- Use the universe as a unique laboratory for probing the laws of physics in regimes not accessible on Earth, such as the very early universe or near the event horizon of a black hole.
- Search for life beyond Earth, and if it is found, determine its nature and its distribution.
- Develop a conceptual framework that accounts for all that astronomers have observed.

Several key problems are particularly ripe for advances in this decade:

- Determine the large-scale properties of the universe: the amount, distribution, and nature of its matter and energy, its age, and the history of its expansion.
- Study the dawn of the modern universe, when the first stars and galaxies formed.
- Understand the formation and evolution of black holes of all sizes.
- Study the formation of stars and their planetary systems, and the birth and evolution of giant and terrestrial planets.
- Understand how the astronomical environment affects Earth.

Connecting Quarks with the Cosmos: Eleven Science Questions for the New Century (<http://books.nap.edu/catalog/10079.html>)

1. What Is Dark Matter?
2. What Is the Nature of Dark Energy?
3. How Did the Universe Begin?
4. Did Einstein Have the Last Word on Gravity?
5. What Are the Masses of the Neutrinos, and How Have They Shaped the Evolution of the Universe?
6. How Do Cosmic Accelerators Work and What Are They Accelerating?
7. Are Protons Unstable?
8. What Are the New States of Matter at Exceedingly High Density and Temperature?
9. Are There Additional Space-Time Dimensions?
10. How Were the Elements from Iron to Uranium Made?
11. Is a New Theory of Matter and Light Needed at the Highest Energies?

Report of the Radio, Millimeter, and Submillimeter Planning Group for the National Science Foundation Division of Astronomy 2005 Senior Review

(<http://www.astro.cornell.edu/~haynes/rmspg/>)

1. How was the Universe born, how did it evolve, and what is its future?
2. What is the dark sector – “dark energy” and “dark matter” – made of?
3. What happened during the cosmic “Dark Ages”?
4. How and when did galaxies form?
5. How were supermassive black holes formed and how do they evolve with time?
6. How do galaxies such as our Milky Way evolve?
7. How do stars and sub-stellar objects form?
8. How does space-time and matter behave at extreme density and pressure?
9. How does the Sun affect the Earth?
10. How do planetary systems form and what determines their properties?
11. What are the properties of Solar system bodies?
12. How did life arise in the Universe?
13. Is there intelligent life elsewhere in the Universe?

SKA Science Booklet:

(http://www.skatelescope.org/PDF/SKA_Booklet.pdf)

Strong-field tests of gravity using pulsars and black holes

- Was Einstein right or will general relativity eventually fail?
- What are the properties of black holes?
- Are there still ripples in space-time from the early Universe?

Galaxy evolution, cosmology and dark energy

- What is the mysterious dark energy?
- How are galaxies born and how do they evolve?

Probing the Dark Ages

- What happened after the big bang and before the first stars and galaxies formed?
- Which came first – stars or galaxies?

The Cradle of Life

- Are we alone in the Universe?
- Are there Earth-like planets around other stars?
- What are the organic molecules in star-forming regions that are relevant to the formation of planets and life?

The origin and evolution of cosmic magnetism

- Is the Universe magnetic?
- How does magnetism affect the formation of stars and galaxies?
- Where has magnetism come from?

Exploration of the unknown

- Can we predict everything in the Universe on the basis of what we know now?
- What else will we discover when exploring the cosmic frontier?