

## Graduate Commencement Exercises Keynote Speech

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June 8, 2018

*Where is Everybody?*

Dear Graduates, Congratulations! You are now hope. You are the hope of your family and community, the hope of your profession, and the hope of the world at large. You represent the leading edge of enlightenment, and according to the champions of Enlightenment from René Descartes to Steven Pinker, you represent our only bridge to a bright future.

You have worked hard and accomplished great things. You all have smarts, perseverance and drive to spare. So what advice could I possibly provide that would be useful to you? I could tell you about pursuing your passion with joy and enjoyment; or about staying hungry for new ideas and opportunities; or about taking your work seriously but not taking yourselves too seriously; but you already know all about that, or you wouldn't have made it this far.

So rather than offer advice, let me invite you to ponder with me a question that is the stuff of science fiction, yet is traceable to the writings of Epicurus in Ancient Greece. Intense interest in this question has been re-ignited by astrophysical discoveries from the past ten years. The question is remarkably simple and yet very profound: *Where is everybody?*

Let me tell you first about our recent astrophysical discoveries. During the past decade we have found and measured thousands of exoplanets orbiting distant stars, including hundreds that resemble Earth. Most of these exoplanets were found by surveying a tiny piece of sky using NASA's Kepler Observatory, and much about their nature was learned from studies using NASA's Spitzer Space Telescope. From these finds we infer that our own galaxy, the Milky Way, contains tens of millions of Earth-like planets with temperate conditions; planets where water could rain down on soil and rock, and where waves could break on sandy beaches; wrapped in atmospheres and magnetic fields, such planets would be hospitable to life not unlike life on Earth. Tens of millions of Earth-like planets with Earth-like temperatures and many of them with water and atmosphere.

If life emerges on even a small percentage of these exoplanets, and if life evolves to intelligence in only a small percentage of cases, and even if intelligent beings pursue technology infrequently, we would still expect thousands of technological civilizations inhabiting our galaxy, very probably communicating among themselves, and possibly traveling between planetary systems. This estimation is known as the Drake equation. It implies that some sort of contact between humanity and such civilizations is extremely likely, but has not happened yet; thus the Cosmic Question *Where is everybody?*

Let me give you a bit of my personal history with this question. I feel fortunate to have grown up in Lebanon, in a society that valued education, and provided access to books and ideas. I read voraciously in high school and was fascinated by this question when it came up. I pondered and discussed it walking around this campus as an undergraduate student; Astrophysics then was a distant dream for me, but AUB was the perfect environment for these discussions, and the perfect launchpad for my trajectory. During my graduate studies at Cornell the question re-emerged when I helped in the assembly of the

Golden Record which is out there today, roaming the Galaxy on board the Voyager spacecraft. Even then I realized that my multi-cultural background was a tremendous asset in thinking about interstellar communication and about summarizing Earth on a Golden Record. AUB had been indeed a perfect launchpad, an intellectual melting pot within multi-cultural Lebanon. By all evidence, AUB still is a unique launchpad, and I hope you will all soon experience this for yourselves. The Cosmic Question remained a secondary pursuit for me while I studied galaxies and cosmology and surveyed the infrared universe. Over the years however, I have come to appreciate it increasingly as a context for considering the state of planet Earth, of human affairs and of our collective behavior, whether constructive or destructive.

Many possible answers have been proposed to the Question, ranging far and wide. At the pessimistic extreme, intelligent species may not survive their technological age for long. At the narcissist extreme, we may be alone in the Universe. I prefer a more realistic scenario, where we have yet to acquire enough science, technology and maturity to achieve contact.

Time for a footnote here to dismiss UFOs as completely irrelevant to answering this question. There is no credible evidence for UFOs. End of footnote.

Now you may be wondering: How can you help ponder this Cosmic Question?

Well, the biologists and medical scientists among you could tell us how likely it is for life to emerge in Earth-like environments over a billion-year history. And how likely it is for evolution to promote intelligence.

The chemists, physicists and geologists could tell us how likely it is for Earth's environment to remain life-friendly for a typical star's lifetime. Conversely, how likely is it that Earth is a fluke?

The educators, historians, and social scientists could tell us how likely it is for an intelligent society to move towards enlightenment, rational development and technology. And how likely it is for a mature civilization to maintain curiosity and exploration after thousands of generations.

The business graduates could maybe figure out societal drivers on a planetary scale in the vast expanse of space.

The aggies could tell us about the ultimate limits of food production for advanced civilizations.

The architects and engineers could tell us how advanced civilizations commanding huge resources might modify their environments to ensure long-term stability. How would they camouflage themselves if they wished to hide and cocoon?

The literature and communication specialists could tell us how to communicate with a species when we know nothing about their history, intellect or spirituality.

And all of you can ponder how do we help humanity survive long enough to make contact?

Dear families, congratulations to you, for your support and patience and yes, your money, have made today possible. I told your graduates that they are the hope of the world, but I won't call them citizens of the world. No, they and you are citizens of the cosmos. Just as you teach children about their living environment, so you should teach them and learn for yourself about your cosmic habitat. Learn the layout of the Solar System, the wonderful diversity of its planets, moons, comets, asteroids and other stuff; learn of our place in the Milky Way galaxy, of our neighboring stars and exoplanets; learn about the Andromeda Galaxy, orbital partner to the Milky Way and about beautiful galaxies and powerful quasars beyond that. And especially learn about this oasis that we call Earth, this "mote of dust suspended in a sunbeam" as Carl Sagan put it.

We are first and foremost citizens of the cosmos, made of stardust and destined for space.

I started out promising no advice today, but I have changed my mind; here's my advice to all of you: Once in a while, find some dark night-sky and look up at the stars. Let your eyes adjust to the darkness and let the twinkling stars draw you closer to the Universe. As you look out, your eyes may see only a few hundred stars, but they are taking in the imperceptible light of millions of galaxies, stars and exoplanets; they are taking in the light from nebulae, supernovae, black holes, and a host of weird and wonderful phenomena dotting the cosmos; they may even be taking in faint signals from a distant civilization.

Whether with naked eye or powerful space telescope, every look at the Universe promises a discovery well beyond the far reaches of our imagination. Astrophysics is the most human of pursuits, an extension of our curiosity about what's behind that hill or beyond that horizon. And the Cosmic Question is a grand expression of the human in Astrophysics.

We are not only citizens of the cosmos, we are inseparable from it. Answering the question *Where is everybody?* will reveal more about ourselves than about the others.

Let me close with T.S. Eliot's elegant verses capturing that thought:

"We shall not cease from exploration,  
And the end of all our exploring  
Will be to arrive where we started  
And know the place for the first time"