# Houghton friends and foes weigh in on global warming FREE

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*Physics Today* **61** (4), 10 (2008);
https://doi.org/10.1063/1.2911159

letters

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**Many readers of PHYSICS TODAY** no doubt recognize the deadly and accelerating assault on the biosphere from modern industrial societies. Thus it is good to see the interview with John Houghton (PHYSICS TODAY, September 2007, page 30) regarding global warming, along with a substantive discussion in the Letters section (page 14) on the pros and cons of nuclear power.

Houghton is doing valuable work spreading the word that humans need to quickly change their behavior and take better care of the biosphere. In the interview he lists several things people can do to diminish their environmental impacts. Unfortunately, like essentially all such lists appearing in the media, his list neglects what is arguably the most environmentally important life decision couples can make—to limit their number of children to two, at most. Houghton seems to recognize that there are far too many people on Earth, but he fails to suggest that everyone can help by not adding to the already enormous human population.

In the same issue, a feature article on echolocation in dolphins and bats (page 40) illustrates the wonders of just a few nonhuman species. Yet the combination of our numerical and material excesses is wiping out numerous species, some amazing and some perhaps less so, at a rate unseen on Earth for at least 65 million years. By the time we are done, humans may well be the cause of the worst mass extinction event in Earth's history. Despite that ongoing catastrophe, for most people—including most scientists I know—life is just business as usual.

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**It is heartening** to read the interview with John Houghton. As a Jewish person by birth, I'll avoid getting embroiled in the religion of those being proselytized, but I wholeheartedly agree with Houghton's argument about global warming. Nonetheless, as a retired chemistry professor, I am duty bound to raise issues that are not clearly visible when one focuses on just the greenhouse effects of carbon dioxide gas.

Houghton mentions the rise in ocean levels that results from global warming and the accompanying changes in rainfall. That rise will precipitate all sorts of climactic disasters worldwide.

The parallel looming disaster is that saturation of the oceans, rivers, and lakes is bound to negatively affect aquatic life, as seen already by the loss of coral reefs off the coasts of Australia, Florida, and Hawaii. Environmental disasters seem to have been relegated to the back burners of the global warming discussion, not just by politicians but also by the scientific community—including, surprisingly, chemical physicists.

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**I am incredibly offended** that PHYSICS TODAY would conduct the John Houghton interview as though he is automatically right and there is no other side to the discussion. I am quite capable of following his scientific argument, as are many other technologically capable Christians.

Houghton's tacit assertion that no one with any knowledge of global warming should disagree with him is hogwash. He makes claims about computer models and the Sun's impact on the climate; his claims are unverifiable and have been shown repeatedly to overestimate warming.

He talks as though all government scientists like himself have no bias, but all industry scientists are corrupt, "vested-interest" moneygrubbers.

Government scientists can no more be trusted than commercially driven scientists. No one is pure, and if Houghton wants to convince me, he's going to have to do it with real evidence and not with politically dictated conclusions reached before the evidence is in.

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**I was very impressed** with both participants in Toni Feder's interview of John Houghton on the subject of global warming. I noted with interest Houghton's scientific rigor in presenting the attendant policy matters and his appeal to his Christian audience based largely on the "stewardship of Earth" theme. As a Hindu-Christian, I was brought up in the two-millennia-old tradition that it is one's actions, not claimed beliefs, that manifest one's faith, the tradition of Dietrich Bonhoeffer, Mohandas Gandhi, Martin Luther King Jr, and Desmond Tutu.

In my presentations to American religious audiences for the past 40 years, I have added another dimension to the discussion. The demand is on Christians, and on the followers of many religions, to serve others, especially the poor, and to live an anti-materialist life. That translates into a slogan—"Enoughness (of material goods) and efficiency (of usage of every material and energy)"—as the core social and technological approaches to carbon dioxide control. Increasing energy efficiency in production and use therefore becomes a most important scientific goal for the physics community.

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**The interview** with John Houghton was very good until the last paragraph. "What will the cost of action be?" Houghton asks, and then answers, "less than the loss of one year's economic growth over 50 years."

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One serious problem inherent in Houghton's assertion is that exponential economic growth is not sustainable. (The economic growth may stem from increases in population or levels of consumption; at the present time, we have one or the other in most places and both in some.) Establishing that there are limits to growth (of population, economic activity, or most any tangible entity) does not require a computer model or anything other than a sharp pencil and a conscious mind. It is easy to calculate that $2^{10}$ equals 1024, so $2^{20}$ is greater than 1 million. The US gross domestic product (GDP) increases an average of about 3.5% annually, so in 50 years it would expand by a factor of approximately 5.6. Is that plausible?

The debate over limits to growth dates back to Thomas Malthus (1766–1834), who treated the question of population, but it did not acquire much urgency until the 1960s, when computer simulations predicted an end to growth for any foreseeable scenario. Obviously, both population and economic activity are limited, but political and cultural values can allow a lot of people to live at the subsistence level or fewer to enjoy affluence. It was only later that the scientific community became aware of chaos and the fact that the modeling of nonlinear systems can be unworkable even for rather simple cases.

How can we generate a numerical estimate for the magnitude of the limits to growth? The ecological footprint, basically an accounting rather than a modeling methodology, provides an answer. The world's level of consumption is already beyond sustainability.[1]

Global warming is merely the crisis du jour. It was not even considered in the computer simulations done more than 40 years ago. That it is a serious potential problem is attested to in a rather cautious statement from the American Geophysical Union.[2] Can it be contained by spending as little as 2% of the annual growth in GDP? For the US, that would amount to about $10 billion in the first year. That may sound like a lot of money. However, some technologies, like carbon sequestration, solve the problem but are untested; others, like fission reactors, are expensive and resource intensive; and some, like fusion reactors, do not exist at all. That $10 billion might be more than enough to cover the cost of research, but it won't come close to covering the capital investment. Then one needs to add in the problem of global peak oil production, for which time-frame estimates range between 2006 and an optimistic 2030. Rising demand for fuel and the resulting higher prices have increased the use of fuel sources such as coal, tar sands, and synthetic petroleum that produce much more $CO_2$ for each unit of usable energy.

Another challenge to addressing global warming is the need for an unprecedented level of international cooperation, given the conflict between developing and mature economies. What one actually sees happening is a race among nations to claim the seabed that is being exposed by the melting of arctic ice. It is even conceivable that global warming could boost growth by providing access to petroleum and other mineral resources before rising sea levels curtail economic activity.

The scientific community has been derelict in its duties. Economists and politicians have been offering growth as the solution to every conceivable problem that plagues humanity. Except for a very few of us,[3–5] the physicists and other scientists who should know better have not challenged the economists or the politicians.

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# Random thoughts on densest packing

I really liked Paul Chaikin's Reference Frame, "Random Thoughts" (PHYSICS TODAY, June 2007, page 8). However, he overlooks the problem of uniqueness. He states that face-centered cubic packing "has recently been proven to be the densest packing." However, FCC can't be the densest because hexagonal close packing is just as dense. FCC and HCP have exactly the same packing density,[1] 0.74. That something with a certain property exists doesn't automatically make it unique with respect to that property. Furthermore, both FCC and HCP have equal thermodynamic stability according to the ideal gas laws that Chaikin presents.

The lack of uniqueness has a certain relevance to the issues of random ordering. Suppose a random ordering is found that has more thermodynamic stability than a crystal. Other forms of random ordering may have the same degree of thermodynamic stability. However, can one even define a random order that is also unique?

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**Thank you** for publishing Paul Chaikin's "Random Thoughts." Chaikin is discussing the most fundamental unresolved problems from the physics and complexity viewpoints: What is random, and what is ordered? Even more interesting is that another fundamental quantity—organization—is created at the interplay between randomness and order at the "edge between order and chaos." Organization, though fundamental for all complexity considerations, can be defined only after we know quantitatively what exactly randomness and order are. That fact makes their definition even more crucial and urgent.

After we have defined organization, we will be able to find out how to improve it and what a "higher level of organization" means. Those discoveries have implications beyond physics and will help us to deal with the constantly changing organization of our complex society.

I even want to speculate that if we understand what organization is, we will be able to improve it and thereby make our lives better. After that, we can start pursuing answers to even more fundamental questions: Is our three-dimensional world best suited for organization? How much organization will be allowed in more or fewer dimensions? A world in how many dimensions allows the best organization? Do we live in the best of all possible worlds? Do multidimensional worlds with higher levels of organization than ours already exist, and are they far ahead of us?


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**In an otherwise** illuminating Reference Frame, Paul Chaikin presents the