science." But I could have added little to that age-old issue. Also, those teachings are nowhere near as complex or difficult to explain as he seems to think. According to Islam, and Christianity and Judaism, the world is governed by a god who responds to prayers and intervenes in physical processes. If science is understood as a search for the causes underlying natural phenomena, then for the faithful of any religion, although some knowledge of the physical world can be gleaned from using the tools of science, the ultimate cause for something's occurrence can be found only in the mind of God. Predictions are possible but only in a limited sense because he is not obligated to abide by the laws of physics. When angry, he may choose to send floods or drought, set mountains quaking, or rain pestilence from the skies—even if any of these involve physical principles being overruled. Although science considers geological phenomena to lie within its domain, Islamic authorities across the world held that the 2004 tsunami and 2005 Pakistani earthquake were expressions of divine wrath.

Hakim suggests that I have used the wrong metric to assess the scientific productivity of Muslim countries. Perhaps. There is certainly no right measure in such matters, so opinions will always differ. In my opinion it is not possible, as he suggests, to consider the impressive technology projects in the Persian Gulf or the Middle East as valid indicators. For example, the "miracle" of Dubai's present economic boom has scarcely any indigenous technical component—it was executed exclusively by multinational corporations and paid for with oil money.

Hakim thinks I should have explained how the industrialized West can be of assistance. Indeed, the West can contribute significantly in material terms in some areas. Laboratory equipment, chemicals, computers, and so forth are important and transferable accessories to science. But they are not science. The crucial and still-missing step toward achieving scientific progress is acceptance of free questioning. Without that, one cannot have forays into the unknown, so genuine science is unattainable. We who live in Muslim societies and who wish for scientific progress must understand that one cannot really fly while in chains. We cannot ache for the enormous power that free inquiry confers while we ban free inquiry itself.

Ismail Demirkan and Aksar Beketov, quoting Bediuzzaman Said Nursi, attribute the decline of Islamic civilization after the 13th century to a materialistic philosophy that brought identity crisis and to a "weakening of genuine faith among Muslims." I would be interested to know of historical evidence suggesting that Muslims had become less observant of their faith after that time. I am also unaware of the concomitant emergence of any "materialist philosophy." How do the authors explain that the most brilliant work of Muslim scientists was performed under the patronage of khalifs such as Harun al-Rashid and Al-Maa'moun, who even today are openly excoriated by the orthodoxy for their pluralistic liberalism and a casual regard for Islamic rituals? Far from marking the end of strong faith, the 13th century was when the rout of the Islamic rationalists (Mutazilites) had been completed and Islamic orthodoxy, inspired by the famous Imam Al-Ghazzali, had achieved ascendancy in all parts of the Muslim world except perhaps Spain. And why did the lessening of faith in Christianity after the European Enlightenment spur science, while the alleged lessening of faith in Islam in the 13th century led to scientific decline?

David Klepper comments on the story of the red heifer. I do not see the breeding of red heifers as having the slightest effect on a conflict wherein two historically constituted peoples have staked their claim to the same piece of land. The end of that conflict cannot come from a better understanding of each other's religion but from a just division of the land in a way that recognizes the inherent rights of both parties.

As for the letter from Anand Saxena and Rajiv Tyagi, I stand by my contention that the Vishwa Hindu Parishad is an extremist Hindu organization that has been responsible for large-scale murders of Muslims and Christians in India. The Gujarat pogrom of 2002, in which more than 2000 Muslims were massacred, occurred with the agreement and active assistance of the Gujarat state government, of which the VHP was a part. The authors' statement that "no authority of the VHP has made derogatory statements toward Muslims or Christians" can be refuted by any number of examples. The first leader of the VHP, Shivram S. Apte, propagated a paranoid Hitlerian vision of a world that is set to devour the helpless Hindu: "The world has been divided to Christian, Islam, and Communist. All of them view Hindu society as very fine rich food on which to feast and fatten themselves."[1] If that is not derogatory, I do not know what is.

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Chilly response to 'warmest year' designation

The present global warming debate pays excessive attention to designating a particular year as the warmest ever (PHYSICS TODAY, December 2006, page 30) or the warmest in the past 100 years. Such declarations, begun by the Intergovernmental Panel on Climate Change (IPCC), risk missing the point that the *trends* are what matter most. The basis for making a claim of the "warmest year" is nothing more than calculating a mean value of temperatures recorded at several land-based stations and combining it with a similar mean over world oceans. Such a "mean" calculation can be misleading since the distribution of observing locations over land and ocean is uneven. Large areas that were only sparsely observed decades ago remain so today.

In a July 2006 report to the House Committee on Energy and Commerce,[1] Edward Wegman of the Center for Computational Statistics at George Mason University stated that the IPCC's assessment of the 1990s as the "hottest decade in a millennium" and of 1998 as the hottest year "cannot be supported. . . . The paucity of data in the more remote past makes the hottest-in-a-millennium claims essentially unverifiable."

In a 2002 report on extreme weather trends, prepared for the government of Alberta, Canada,[2] I documented that the 1930s had the hottest summers in Canada and possibly in the conterminous US. In a recent reanalysis prompted by Steve McIntyre, weblogger at http://www.climateaudit.org, NASA has now designated 1934 as the hottest year in the US and not 1998 as previously claimed.

As someone who has spent more than 50 years in the science of weather and climate, I find this designation of "warmest year" misleading and almost meaningless.

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Mysteries of the glass transition

In his intriguing Reference Frame "The Mysterious Glass Transition" (PHYSICS TODAY, February 2007, page 8), James Langer discussed the challenges of glass science. This interdisciplinary field between physics and chemistry has increasingly important applications that now even include the pharmaceutical and food industries.

I like to picture the liquid–glass transition via the following model. Consider a Langevin particle in one dimension moving in an asymmetric double-well potential. The system has a finite relaxation time that diverges as temperature goes to zero, because the relaxation time is related to the barrier to be overcome in the usual Boltzmann expression characterizing rate theory. Consequently, when the system is cooled at a finite rate, it eventually falls out of equilibrium. That process exhibits most of the properties associated with the liquid–glass transition:[1–4] The liquid–glass transition is gradual rather than sharp, its transition temperature is lower for slower cooling, and the liquid–glass transition is associated with various nonlinear and hysteresis effects.

What happens in the glass transition of the asymmetric double-well potential is that jumps between the two energy minima cease and the system freezes into one minimum or the other.[5] A glass transition occurs whenever a system doesn't have enough time to equilibrate. Computer simulations confirm that picture for realistic liquids also. The non-Arrhenius behavior usually observed in supercooled liquids is not reflected in the simple model I described but is easily modeled by assuming that the activation energy increases as the temperature decreases.

If that simple model accurately reflects the basics of the liquid–glass transition, then the transition is also just a freezing into an energy minimum.[5] (Although the distribution of frozen-in energies may deviate from the equilibrium distribution,[4] it is a minor effect, and to zeroth order the system just freezes configurationally.) Does that eliminate the mystery? Not at all; an enormous challenge still lies in understanding the fairly universal properties of the ultraviscous liquid phase above the glass transition where the viscosity becomes almost 10^{15} times larger than that of ambient water. Everything is exceedingly slow in that phase, right? Well, most molecular motion is vibrational, and transitions between different minima are indeed rare. But the diffusion of transverse momentum is actually extremely fast because the exceedingly large kinematic viscosity of the Navier–Stokes equations is the transverse momentum diffusion constant. Thus the ratio between the particle diffusion constant and the transverse-momentum diffusion constant goes from roughly 1 in the less viscous phase to a number of order 10^{-30} just above the liquid–glass transition.

Such small dimensionless numbers are rare in condensed-matter physics; they appear to signal that an ultraviscous liquid is more accurately thought of as a solid that "flows." Researchers are not certain, but the existence of a very small dimensionless number characterizing such liquids gives hope that a fairly simple universal theory exists.

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As someone who has long been interested in the glass transition and glassy-state kinetics, I would like to comment on some of the issues raised by James Langer in his Reference Frame column.

I affirm Langer's statement about healthy contentiousness. Whether or not the glass transition has thermodynamic roots definitely makes for exciting science. The reason some of us think thermodynamics is important is that we find it difficult to dismiss as coincidences the similarities in the values of the kinetic temperature T_0 and the thermodynamic Kauzmann temperature T_K. One common objection to the Kauzmann analysis, that an amorphous solid should not have zero

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