Douglas R. Hofstadter

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James Glazier, Director
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Dear James,

I am writing to you on behalf of Dr. Greg Huber, who has applied for a senior faculty position at Indiana University, jointly in the Biocomplexity Institute and in Informatics.

I have known Greg for some two decades now, starting when he was an MIT undergraduate, then during his graduate career in physics at BU and his various post-doctoral positions at Berkeley, Copenhagen, Chicago, and Arizona, and most recently his faculty position at U Mass Boston. From the earliest time I met him and up till this very moment, I have considered Greg to be an extremely original thinker and creator. In my eyes, Greg stands out for his multi-talentedness, his mathematical depth, his physical insight, and his wonderfully idiosyncratic curiosity and liveliness of spirit.

Very early in life, Greg discovered the beauty of mathematics, and in high school he made a number of discoveries that would be first-class achievements for any university math student. As an undergraduate at MIT, despite doing excellently in mathematics, he opted for physics. After graduating from MIT, Greg joined my research group at the University of Michigan, thinking he would go for a doctorate in cognitive science, but after a year or so he realized that his true passion was physics, and he moved to BU to work with Eugene Stanley, which I think was the right decision. The contact we had during that Michigan year, however, was very fruitful for us both. Ever since then, Greg has steadily extended his creative trajectory as a physicist, exploring percolation, fractals, scaling laws and the renormalization group, phase transitions, chaos, biophysics, and more. In this letter, I can only hint at the breadth and depth of Greg's work.

In his Ph.D. thesis, he made important discoveries concerning the vortex states in systems governed by the complex Ginzburg-Landau equation. Such systems exhibit a form of chaotic dynamics that is akin to turbulence, and Greg was the first to understand how this turbulence arises. He was also the first to characterize the glassy vortex arrays in such systems, and the term "Huber glass" has appeared in the literature.

While at Chicago, Greg co-authored with Sidney Nagel a beautiful and now famous paper in "Nature" on the ring-shaped stains formed by drying liquids — the so-called "coffee-stain problem". This problem had gone unsolved for a long time, but in the end the theoretical picture provided by Huber and Nagel was simple and compelling, and experiments by Nagel and his group verified it in many details.

More recently, sparked by his collaboration with Ray Goldstein at Arizona, Greg has applied his knowledge of nonlinear physics to fluid dynamics in biology. One of the questions he has investigated is how bacteria move by rotating their flagella. His papers with Goldstein on this subject are not only mathematically elegant (relying, as they do, on classical differential geometry) but are also good physics, and make testable predictions. Toward this end, upon his recent move to Boston, Greg forged a collaboration with Howard Berg's lab at Harvard, famous for its studies of bacterial motility.

At this point I have to say that my own richest collaboration in the past several years has been the exploration, with Greg, of a novel type of number-theoretic chaos that arises in so-called "meta-Fibonacci" sequences — that is, recursively defined functions exemplified by the nested recursion relation $U(n) = U(n-U(n-1)) + U(n-U(n-2))$, with initial values of $U(0) = U(1) = 1$. This function, which I invented many years ago and studied to some extent then, turns out to be extremely chaotic, but the nature of its chaos has never been fully understood (indeed, $U(n)$ is not even known to exist for all $n>0$). In order to try to penetrate its mysteries, Greg generalized it to a two-parameter family of functions $Q(n-Q(n-r)) + Q(n-Q(n-s))$, where r and s are fixed positive integers. Of course, some initial conditions have to be specified to get such a recursion relation off the ground. Sample initial conditions include: $Q(n)=1$ for all $n<N$, or $Q(n)=n$ for all $n<N$, or $Q(n) = [n/2]$ for all $n<N$, and so forth.

No matter what the initial conditions are, it turns out that if such a function "lives forever" (i.e., is well-defined for all $n>0$), it invariably exhibits very bizarre and irregular patterns; contrariwise, when a function of this sort "dies" (i.e., becomes undefined for some finite value of n, because one of the arguments on the right side becomes negative), the n-value at which "death" takes place is scattered highly irregularly above the r–s plane.

Together, Greg and I have carefully and systematically explored the behavior of the simple-looking but strange family of Q functions. We have done much empirical research by computer, but we have also rigorously proven key theorems. There is an astonishing wealth of unpredictability in the Q functions, and we are actively continuing our research into their behavior. We have delivered invited talks on "Q-theory" at many universities and conferences, including the University of Toronto, the University of Arizona, the Theory Division at CERN, the Cargèse conferences, the Universidad Católica de Chile, the University of San Francisco, and so forth.

For me, one of Greg's most outstanding traits as an intellectual is his profound interest in the strange twists and turns that constitute the history of science, particularly of physics and mathematics, and many of our most rewarding conversations over the years have dealt with trying to figure out the thought processes of such innovators as Maxwell, Galois, Heisenberg, Dirac, Pauli, and Feynman, when they made some of their famous discoveries. These conversations have stimulated me enormously in my studies of how analogy pervades physics, a topic that I intend to write a book about.

As a teacher, Greg is obsessed with simplicity and clarity; he strives to boil things down to their conceptual core, their gist, their essence. He always heads straight for the crux of the matter, cleanly carving away the superficial to expose the deep, and something that I hugely appreciate is how he always brings in enlightening and often amusing historical anecdotes. Greg's lectures, of which I have heard a good number, are unfailingly neat and clear, afford nuggets of insight, and often are rife with humor, to boot. In short, Greg is exactly the type of professor I would most have loved to have when I was a student (both undergrad and graduate).

I would be remiss if I failed to comment on Greg's human qualities. An extraordinarily generous and kind person, Greg is one of the most honest and gentle people I have ever met. An exemplary dad to his twin children, he is also a delightfully whimsical fellow whenever he wishes to be. He is gifted in many "extracurricular" ways, such as drawing, humor, poetry, and language.

In summary, Greg Huber is one of the three or four individuals who have most stimulated me intellectually in my entire life. Thinkers and creators at his level come along very rarely. Sadly, he is suffering at U Mass Boston, where the teaching load is stifling and the research environment is not nearly rich enough. Were he to wind up at IU, that would obviously be a terrific personal boon for me. But wherever he winds up, his presence will deeply enrich his department — indeed, the entire university community. To my mind, Greg Huber's presence would add a sparkling jewel to Indiana University. Please give him your most serious consideration.

Sincerely,

Douglas R. Hofstadter

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