John Hawley (1958–2021)

John Hawley, a major pioneer in numerical astrophysics, passed away on 12 December 2021. Besides having been outstanding as a scientist, teacher and administrator, he will always be 'the funniest man in astrophysics' to many who knew him.

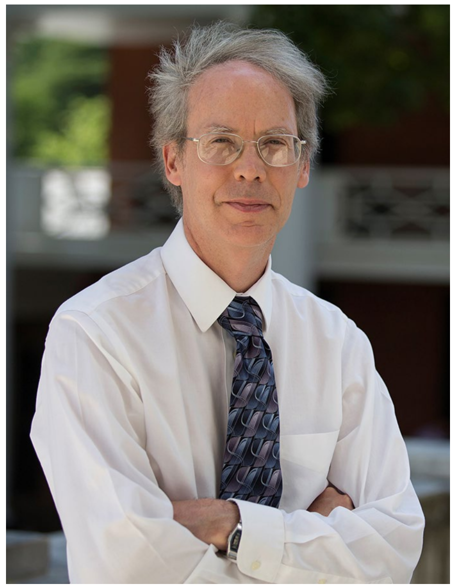
On 12 December 2021, John Hawley lost his brave two-year battle with colorectal cancer, and the field of numerical astrophysics lost one of its great trailblazers. John's legacy continues to be felt strongly today by way of his work, and the many leading numerical astrophysicists who have been mentored and influenced by him.

On first encounter, John Hawley might have seemed reserved, perhaps even diffident. But to those who knew him, he was a delightful colleague and mentor, a very successful teacher, and possessed of a most devastating, deadpan sense of humour. He will be deeply missed.

John was born on 23 August 1958 in Annapolis, Maryland. His father, Bernard Hawley, was a Presbyterian minister who entered the profession because he thought it would bring him closer to a deeper understanding of the world at large, and he encouraged a strong interest in science in his children. Two of John's siblings became prominent scientists: his brother Steven holds a PhD in astronomy and had a 30-year career as a NASA astronaut, including the launches of the Hubble Space Telescope and Chandra X-ray Observatory; his sister Diane is a professor of biochemistry and molecular biology at the University of Oregon.

While John was still very young, the family moved to Salina, Kansas, where he grew up. Inspired by his family as well as by the Gemini and Apollo space programmes, John had an interest in astronomy from a very early stage. When, after high-school graduation, he chose to go to Haverford College, one of the strong draws lay in the promotional materials that he received: a course in cosmology was highlighted, taught by Bruce Partridge. John's senior thesis project at Haverford, a calculation of the nuclear reactions in the helium-burning shells of red giants, was his first introduction to computational astrophysics. Of at least equal importance, a seminar speaker introduced John to the topic of accretion disks, and highlighted the fact that the disks were thought to be highly turbulent and dissipative. The dynamical mechanism by which this breakdown occurred was, at the time, poorly understood.

Now firmly hooked on numerical astrophysics, John chose to work with Larry Smarr at the University of Illinois for his PhD. Larry was a pioneering numerical relativist, and John's (1984) thesis project was an axisymmetric, general relativistic calculation of gas infalling onto a black hole. Primitive by today's standards, such a calculation was at the time just barely possible, and represented a major computational advance. More realistic disk simulations of black hole accretion were still some ways off.



John Hawley (1958–2021). Credit: Dan Addison, University Communications, University of Virginia.

After the completion of his thesis, John accepted a highly competitive Bantrell Fellowship at Caltech with the group headed by Peter Goldreich and Roger Blandford. Accretion disks and their stability remained at the focus of his research due to a remarkable discovery by John Papaloizou and Jim Pringle that thick disks were unstable to a global instability that had no local counterpart. The nature of the instability was not well understood at first, but matters were fully elucidated by the Caltech group (with seminal contributions from postdocs Jeremy Goodman and Ramesh Narayan). John performed a stunning series of numerical calculations that not only pinpointed a technical error in the linear calculations (immediately corrected!) but also revealed the interactive nonlinear development of the unstable modes — a development very novel for its time. After the instability ran its course, isolated, bound, long-lived embedded structures dubbed 'planets' formed. This result was totally unforeseen. Within a day of the discovery, the Caltech group produced a closed-form analytic solution showing how such structures can arise and be maintained from a combination of Coriolis and pressure forces acting in a rotating system. This experience convinced John that numerical simulations, when combined with the power of analytic insight, comprise a uniquely powerful synergistic tool, one with a bright future ahead of it.

John joined the faculty of the University of Virginia in 1987, where I myself had been hired only a few years before. The very first day he arrived, John and I were talking about films we enjoy, and John asked me what movie, in my view, was the most far-reaching and revealing comedy that had ever been made. Without any hesitation, I responded "*Dr. Strangelove*". John's eyes lit up. Our match was evidently meant to be.

John and I began working on the dynamics and thermodynamics of the intracluster medium of rich galaxy clusters, which was then a University of Virginia specialty. As it happened, we were both keen on incorporating magnetohydrodynamical (MHD) forces into our work. I had come to appreciate how subtle such effects could be in the context of thermal physics, because of the new degrees of freedom a magnetic field imparts to a fluid; John, with Charles Evans and later Jim Stone, had been developing a novel numerical scheme for incorporating MHD forces in general relativistic codes. This 'constrained transport' method ensures that a vanishing divergence condition is built deeply and efficiently into the heart of the numerical scheme. When, in the summer of 1990, John showed me a paper that added a magnetic field for 'post-processing' into an otherwise fully hydrodynamical disk calculation, it seemed dubious to me. However, I was interested enough to work the problem for myself.

Expecting to find little more than some complicated waves with magnetic forces present, I was stunned to find an extra mode popping up that grew exponentially. I should not have been surprised, for this was just the sort of extra degree of freedom I had noted in my earlier work in galaxy clusters. But the instability was so powerful, and it was far from clear where it might be leading. John was alas on an end-of-summer break, and I had an agonizing wait until he returned before the next step could be taken. When he did return, he grasped the implication immediately. "This is important," he said in a hushed tone, and ran down the hall to his office to set to work.

Within hours, John's MHD code produced its first output: a scraggily line contour plot, state-of-the-art at the time, of a little column of magnetic field growing a string of mushroom-like extensions along its length, in complete agreement with linear theory in the early stages, but then developing complicated nonlinear structures. We were definitely on to something.

While others before, including Subrahmanyan Chandrasekhar and Evgeny Velikhov, had started down this road, no one had appreciated the generality of what is now known as the 'magnetorotational instability' (MRI), its effective independence of field geometry and strength (provided that the field is not too strong!), and certainly no one before had the faintest idea what the nonlinear outcome of the instability would be. John was awarded the Helen B. Warner Prize of the American Astronomical Society in 1993 for leading the way in developing the codes and carrying out the calculations that showed that Keplerian rotation, combined with any weak magnetic field in a gaseous fluid, will become turbulent with enhanced angular momentum transport. Jointly with the current author, he was awarded the 2013 Shaw Prize in Astronomy for this work and its later development.

John's contributions heralded the arrival of numerical MHD into accretion theory, and other venues as well, and today it is an industry unto itself, pursuing directions that John and his collaborators helped to initiate, including the study of both disks and the jets that are self-consistently produced. (The MRI has thermal analogues as well.) The remarkable disk simulations used for comparison with the Event Horizon Telescope images rely on the MRI to power the underlying dynamics, and many of the codes used today are direct descendants of originals that John helped develop.

John's lasting monument is the field of numerical accretion disk physics itself, of which he was a founding father. But he was also a great mentor, training many of today's leading numericists, and a great classroom teacher. His astro 101 and cosmology courses became legendary for his clarity of presentation and deadpan sense of humour. Students came from all walks of life. When one of them expressed confidence to John that they would do well on an upcoming exam because Jesus would be with them, John gently advised the student that Jesus also would surely encourage them to study very hard.

In 2006, John became chair of the astronomy department at the University of Virginia, and his organizational talents were not lost on the university administrators. In 2012, he was asked to become the associate dean for the sciences, and he accepted the rather difficult task of managing the demands of a vast cohort. By all accounts, he flourished, which is hardly a surprise.

While still a postdoc, John met his future wife and life partner, Katherine Holcomb, at a conference on general relativity, where she was presenting. From that point on, he was very fond of noting that "Attendance at conferences can lead one into new and rewarding directions!" With Kathy, he wrote a very well-received cosmology textbook, *Foundations of Modern Cosmology*.

In 2017, John was an after-dinner speaker, a role to which he was much accustomed, at the University of Virginia astronomy department's annual formal dinner. It will be recalled that 2017 was the year of the famous gaffe at the Academy Awards where *La La Land* was mistakenly announced as the Best Picture Academy Award winner, before an awkward correction ensued. At the dinner, John was handed an envelope with the name of that year's outstanding teaching assistant. On opening the envelope, he said: "The winner is… [pause]… *La La Land*!" In Kathy's words: "I have never seen a room erupt the way it did when he said that."

We will miss you John: your presence, your work and your more-than-ever much-needed sense of humour. ❐

Steven Balbus ✉
Department of Physics, University of Oxford, Oxford, UK.
✉*e-mail: steven.balbus@physics.ox.ac.uk*

Published online: 11 February 2022
https://doi.org/10.1038/s41550-022-01608-z