This is a draft of the text of David W. Hogg's contribution at the memorial service for Patrick Huggins in the Department of Physics at New York University on 2014 March 12.

My name is David Hogg, I am an astronomer here in the Physics Department. I have known Patrick Huggins for about twelve years. He was my colleague and my faculty mentor.

Research

Patrick was interested in the fundamental processes of astrophysics, in which gravity, radiation, magnetic fields, and atomic and molecular physics combine to produce the spectacular and important astrophysical objects we see. In the time I knew him, he was particularly interested in planetary nebulae, which are colorful extended objects that show beautiful rotational point symmetries. They also represent important phases in stellar evolution in which stars eject gas and dust into the interstellar medium. Importantly to Patrick, they are not understood mechanically. And yet they provide many observational handles in which theoretical ideas about accretion, jets, magnetic fields, and molecule-photon interactions can be tested. (I think it was also important to him that they are so beautiful!)

Most of Patrick's work over his forty-some years of astrophysical research related to the interactions between stars and the interstellar medium. He was interested in the chemical composition of the gas in the Galaxy, the mechanisms by which stars—which are massive—overcome gravity and blow off material, and the complex ways that atomic and molecular transitions process radiation fields. When gas in the envelope around a star is illuminated by the strong radiation from the star, the radiation dissociates molecules and ionizes atoms, it pushes them outward, and then they re-radiate, often at different frequencies. These processes create spatial heterogeneity in both the radiation field and the chemistry, which then also create inhomogeneities in the phases of the gas and dust.

The underlying physics of these objects is simple—transitions and momentum transfer in atoms and molecules—but the observations and overall theory are complicated. The observations are complicated by the fact that many important species do not have easily observable transitions, and that many of Patrick's favorite objects are optically thick even in the infrared. The theory is complicated by the fact that there are just so many transitions

and species to consider, great judgement is required to decide what to calculate and what to ignore. It is that kind of judgement in which Patrick was so talented and so thoughtful.

There are two comments I would make here: The first is that astrophysical systems are always multi-phase. Look at the clouds in the sky and beautiful sunsets: You won't explain those things with equilibrium thermodynamics!

The second is that understanding requires facility with both observations and theory. Patrick had that joint facility. He wasn't afraid of complexity and messiness. He was always extremely honest and dispassionate about the uncertainties (theoretical and observational) inherent in research on complex things. He wanted to help explain the beautiful, real, important objects of the universe.

By the way, one side note: The boomerang nebula you see over there (the bow-tie-shaped nebula): That's the coldest astrophysical object known in the Universe. It has a core that is only 1 Kelvin in temperature, which is substantially colder even than the Cosmic Microwave Background radiation. Anyone want to take a shot at explaining that?

Teaching

Patrick was a wonderful teacher, and a research mentor to many very fortunate undergraduates.

Most of my interactions with him in an educational context center on the course *Observational Astronomy* that he designed, created, and taught here at NYU. This class is very unusual, because it is simultaneously an introduction to astronomy, and a difficult technical laboratory class, in which the students learn to be "backyard astronomers". For the purposes of running this class, Patrick negotiated the existence of the rooftop observatory on the roof of 715 Broadway across the street, and had it built. Any of you who has interacted with NYU administration, will know that this is represents a feat that few would *even attempt*, let alone complete and maintain successfully for many years.

When I was a junior faculty member and served as Patrick's TA for this course (in order to learn how to teach it myself), the thing that impressed me was not just that Patrick had designed a totally unique, hands-on astronomy course and built everything and all the labs from scratch. What impressed me was his thoughtfulness about what students learn and how. The labs were carefully designed so that each only introduced a small number of important

ideas. They required both intellectual and physical capabilities, which made them demanding but also fun. I was impressed that Patrick seemed to enjoy every class and the students treated the class like it was summer camp. At the same time, they learned things they could not have learned in any other class at NYU.

Personal notes

When I arrived at NYU, like any new faculty member, I had no idea what was going on. I didn't understand what everyone was fighting about in faculty meetings, how I should recruit graduate students, or how seriously I should take my committee assignments. I asked Patrick to act as a professional mentor to me. Could we meet once a week for an hour, with no agenda, to talk about whatever?

Patrick said yes, of course, and these mentoring meetings meant a great deal to me. First of all, Patrick had a deep understanding of the organizations that are the Physics Department and NYU. When I would get mad about something, Patrick would say "There is no NYU, there is only a group of people. Organizations are collections of people." He would always understand the good in those people and their points of view. He was simultaneously wise and also very kind.

I guess kindness and widsom are two very related things.

Patrick taught me how not to waste time in meetings. He taught me how to advise graduate students with very different interests and capabilities. He taught me how to think about the whole undergraduate educational program, which is now one of my main jobs in the Department.

He was not a procrastinator; he never left things for the last minute: his grant-proposal writing, teaching preparation, or anything else he did. I can't say I really learned not to procrastinate, but it sure impressed me.

Most importantly, Patrick Huggins cared about my success as a young faculty member and astronomer here at NYU. He was always generous with his time, always encouraging and sympathetic. As many of you know, I have loved my time here at NYU, and that is in no small part due to Patrick. It was my great privilege to spend time with him and benefit from his wisdom and his friendship.