SEATTLE ASTRONOMICAL SOCIETY

The

Webfooted Astronomer

October 2002

Sloan Digital Sky Survey: The View From the Trenches

By George Best

> **October Meeting**
>
> Constance Rockosi
> Post Doctoral Fellow
>
> University of Washington
>
> Wednesday, Oct. 16
> 7:30 p.m.
>
> Physics-Astronomy Building
> Room A102
> University of Washington
> Seattle
>
> Come early at 7 p.m. for coffee and to visit with your fellow members.
>
> Bring your slides to show after the program.

THE speaker for our October meeting is Constance Rockosi, a post doctoral fellow at the University of Washington. She will discuss the Sloan Digital Sky Survey.

Rockosi received her PhD at the University of Chicago in 2001. While at Chicago, she worked on the imaging camera and many other aspects of the Sloan Sky Survey.

She has been with the Sloan Digital Sky Survey from the beginning and will give us a view from the trenches.

At Washington, she is studying the distribution of stellar populations in our galaxy to see what they can tell us about Galactic structure and evolution. She is also studying stellar composition of galaxies in the local universe.

The Seattle Astronomical Society meeting will be held Wednesday, Oct. 16 at 7:30 p.m. in room A102 of the Physics-Astronomy building.

Dark Skies Northwest will hold its monthly meeting prior to the SAS meeting from 6:30-7:30 p.m. in room A216 of the Physics-Astronomy Building.

Seattle Astronomical Society

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Hugh Entrop: SAS's Pioneer Astrophotographer

By Alan Macfarlane

ONE of the most creative pioneer astrophotographers the SAS has ever had in our membership is Hugh Entrop. Since Christmas, many of you have missed Hugh at our meetings and asked where he has been the past six months.

Hugh and I usually talk on the phone a couple of times each month, and early in the year he was not answering his phone. Many of you also have had the same experience. Because he has lived for several years alone we were concerned that something had happened to him. Finally I was able to contact him through his church and learned that he had fallen in his kitchen, injuring his hip badly, and was suffering by himself for two or three days until discovered. Hugh is now at The Greenwood Park Care Facility at 133333 Greenwood Avenue, phone number (206) 362-0303.

Hugh has had a very interesting and creative life. As a young man he became fascinated with hydroplanes, both in building and racing them. He then went on to break the World speed record for hydroplanes! He was associated with hydroplanes for many years thereafter.

During this time he began working with Herm Dittmer and Howard Louth at the Boeing Wind Tunnel, and Hugh and Herm worked together in the Wind Tunnel Model Shop. Their abilities to design and do superfine machine shop work was outstanding.

Sometime in the early sixties, both Herm and Hugh discovered astronomy, telescope making, and astrophotography. Herm was more involved in building his own equipment, while Hugh had learned about a fine new Maksutof telescope, the 3½-inch Questar. Because of the superb optics and construction of the Questar, Hugh decided to put it through several fascinating tests. He set up his scope in Alki and started taking pictures of his brother in his office on second avenue. Then from the same spot, he and Herm photographed license plates of cars parked on Western Avenue. The Questar people were so astounded with these two pictures, they put them in Questar ads on the inside front cover of Scientific American.

Hugh also was doing astrophotography of deep sky objects, planets, comets, and beautiful solar work. Here was a dedicated as-

Hugh Entrop *(Continued from page 3)*

trophotographer who was taking an f/19 3½-inch telescope and turning out results that rivaled Mt. Wilson! Questar continued for many, many years to feature Hugh's superb astrophotography in their ads inside the front cover of *Scientific American,* plus brochures, and ads in *Sky and Telescope.* Hugh has become internationally famous for his unbelievable photographs.

Some years after he and Herm had begun astrophotography in black and white using 103A0 film, they discovered that color slide film would give them more resolution, so at this point Hugh's photos of the nebulas, planets, sun, and comets were in color. Questar also wanted him to test different glass types on the 3½-inch. He tried quartz, cer-vit, and Pyrex, and ended up saying Pyrex was the best. He did many other tests on the Questar, which have improved it. Hugh was the reason in 1965 I got into mirror lenses and Celestrons, and eventually in 1980 succumbed to having a Questar myself.

Not only was Hugh dedicated to building, modifying his Questars (he now also had a 7-inch), but he was also dedicated to his darkroom work, which was way above state-of-the-art. So dedicated was he that he would pack up his telescope gear in his Volkswagen beetle, and at 3rd quarter moon, would drive down to Westgard Pass in California, shoot for 4 or 5 nights in the dark of the moon, and then drive back just in time to develop what he had shot, and then off again. Often Herm Dittmar would drive down with him, and the two would go through the same Japanese tea ceremony together. All this was with slow film, small apertures, field rotation, and questionable weather, but pioneering spirit. Hugh Entrop's work is a great example of skill being more important than equipment. His equipment was great, but it is the factor of his consummate skill that has produced those amazing photographs.

Besides all this, Hugh has a sparkling outlook, a definite humorous approach, and has helped me and many of you with a completely unselfish heart. We have treasured his friendship. What does one say about one's mentor? I've learned so much from this gentleman! Hugh Entrop has done so much for all of us, astronomy, particularly astrophotography, and shown the world what can be accomplished with small telescopes and superb, marvelous talent! We should all hold a thought and a prayer for Hugh's recovery from this debilitating injury.

Join the SAS Board

By the SAS Board

THERE is only one more month until the club elections, and the terms are up for all the board positions. If you are considering the possibility of volunteering for any of the officers' positions, please contact one of the board members soon. Here is a summary of what each position entails.

President

My experience of being president of the club may be very different from past presidents. After the basic maintenance jobs are fulfilled, there is a lot of room to do your own thing. I preside over the board meetings, the monthly club meetings, and being an ambassador to the community. I am usually the first one that is called when a special astronomical event is to take place (because my name and number are on the Web site). If I can't answer questions, I know people in the club to refer them to. I spend a couple hours each month e-mailing members and the public regarding SAS events or fielding requests for our help at other events. Instead of promoting and developing my ideas of what the club should be, I tried to understand where the club wanted to go. I preferred to have questions hashed out at board meetings and have larger decisions brought to members at the monthly meetings. Having also experienced the job of Treasurer a few years ago, I was not willing to spend club money haphazardly. Maybe I was too cheap.

I spend 8–10 hours a month doing the job of president. Personal costs include car fuel, postage, and a few long distance phone calls. Benefits: meeting fascinating people, making friends, working with exceptional folks, and having fun as well as a bit of healthy stress. If you have any questions, call me at 206-246-0977 or e-mail me at missioncontrol13@juno.com. – *Mary Ingersoll*

First VP–Programs

The job of the First VP–Programs is to obtain speakers for the monthly general meetings of the SAS. There are many sources for speakers. In particular, a good source is the University of Washington Astronomy Department. – *George Best*

Second VP–Education

This person is the contact for people or groups looking for an astronomy program orspeaker. You do not need to do all the pro-

(Continued on page 6)

Board *(Continued from page 5)*

grams yourself; you do need a phone and/or email to post notices of upcoming volunteer opportunities on the Web site and newsletter and to contact folks that are usually interested in giving astronomy programs. Note: The New Astronomer Seminars are NOT the VP's responsibility. They are a gift to the club from Karl and Judy Schroeder. – *Karl Schroeder*

Third VP–Membership

The VP, Membership responds to e-mail and telephone inquiries about SAS membership. Upon request, mail SAS brochures and membership applications to potential members. Acquire from and maintain a supply of materials for the new member packets including but not limited to a cover letter, SAS brochure, schedule of SAS events for the current year, list of local and regional astronomical resources (existing lists created by SAS members), list of recommended astronomical references (existing list created by SAS members), flyer (from Astronomy and Sky and Telescope magazines) with advice on starting out in astronomy, flyer (from Astronomy magazine) with advice on purchasing a first telescope.

As needed, purchase address labels and envelopes for new member packets. Upon receiving a list of new members in Microsoft Word format from the SAS treasurer, set up Word merges and print out cover labels and address labels. Assemble and mail the new member packets. Average: 2.5 hours per month. – *Ron Leamon*

Fourth VP–Publicity

This position requires a couple hours a month on board meetings a couple more on compiling and distributing the monthly email press release, and one or two more on answering machine duty (making/changing recordings). It comes to about 5 hours per month.

One additional task is to tweak the annual membership brochure and events flyer at the beginning of each year, and having more printed up, which usually takes a few hours each.

(Continued on page 8)

Astronomical League Observing Awards

Congratulations to **Patricia Lewis** for receiving the Binocular Messier Club certificate for observing 50 or more Messier objects using only binoculars (Pat observed 53), and to **Steve Van Rompaey** for receiving a Messier Club Certificate for independently locating and observing at least 70 of the Messier Objects.

From the President's Pen . . .

Apollo Still Making Impact

By Mary Ingersoll

THE Internet was all-abuzz in September after Canadian amateur astronomer, Bill Yeung, discovered a "mystery object" while observing the night sky from El Centro, Calif.

The object, named J002E3, was sited on Sept. 3, and within a few days hundreds of confirmations, measurements, photographs and speculations fueled fears that this might be an asteroid headed for collision with Earth. By Sept. 12, astronomers Carl Hergenrother and Robert Whiteley at the Lunar and Planetary Laboratory at the University of Arizona measured the reflected light and determined that it was not an asteroid but had the colors of a rocket booster. On Sept. 18 it was confirmed that the color came from white Titanium oxide paint, a paint that was used on the Apollo Saturn S-IVB upper stages.

It is now believed that J002E3 is the third stage of the Saturn rocket of Apollo 12. This second flight to the Moon was manned by Charles "Pete" Conrad, Jr., Richard Gordon, Jr., and Alan Bean. Only two such stages were sent toward the Sun (Apollo 11 being the other), the third stages of the next five flights were purposely dropped onto the Moon to calibrate seismic instruments set up by the earlier missions. However the stage did not burn up in the Sun, but rather got "hung up" at the L1 Lagrangian point between the Sun and the Earth where it started orbiting the Sun. As it orbited the Sun, it sped along eventually lapping the Earth's orbit and then got captured by the gravity of the Earth pulling it into a geocentric orbit. It is expected to continue its chaotic orbit around Earth until mid-2003 when it will shift into solar orbit.

Dr. Paul Chodas of the Near-Earth Object Program Office at NASA's Jet Propulsion Laboratory says, "This type of orbit can't last very long, that's one reason it would be very unlikely to find an asteroid with an orbit like this." Chodas believes there is a 3 percent chance that the third stage will re-enter Earth's atmosphere within the next 10 years. There's also a chance that it could end up impacting the Moon. "Modern Earth-based sensors, especially those in the infrared wavelengths, would probably be able to detect the impact," he said.

Then Apollo 12's third stage would join its brothers and sisters on the Moon, which leaves me wondering where Apollo 11's third stage is now.

Board *(Continued from page 6)*
Someone who wants to really develop much wider media contacts, and to coordinate publicity efforts with other area clubs would have a *lot* of leeway to grow this position. – *Brian Allen*

Treasurer
If you want a job with lots of people contact, this is for you! The treasurer takes in all member dues and magazine subscriptions, keeps the member database up to date, sends monthly labels to the circulation team, makes bank deposits, and pays bills. Need good computer skills and Access, Excel, and Word. The club copy of Quicken will transfer with the files to your computer. – *Judy Schroeder*

Secretary
Interested in a way to contribute a little more to SAS, then consider throwing your hat in the race for SAS Board Secretary. Two months after joining SAS, I was elected secretary. If I can do it, you can too! And if you're worried about stiff competition for the post, don't be. Total number of hats in the ring so far = 0.

I have served as secretary for the last two years, and have found it a rewarding experience on a number of levels. I've had the privilege of working with terrific folks on the board. They are a great group of people that really care about SAS, and want to keep it moving forward. Also, serving as secretary has allowed me to get to know many more SAS members. Finally, I have had the opportunity to take notes and write up minutes for our speakers' presentations. I have never regretted attending even one of our monthly Wednesday meetings! And writing articles about the meetings has enabled me to learn something new and interesting each month. So here are the basic duties: Attend monthly general meetings and write an article about it for SAS newsletter. Attend monthly board meetings, take notes, write up and distribute minutes. Be the keeper of the "black hole" (SAS file archive box).

At the monthly general meetings I use a tape recorder to capture the lecture (with the speaker's permission, of course), and play it back later while writing the monthly newsletter article. At the monthly board meetings, you can take handwritten notes or bring a laptop to take notes.

You are free to make of the position whatever you wish. I opened up a new astronomical viewing site at Rattlesnake Lake for access by SAS members, and got our new www.seattleastro.org domain name, among other things. Serving as secretary is a great way for anyone to contribute to the SAS. – *Greg Donohue*

October 2002

Sun	Mon	Tue	Wed	Thu	Fri	Sat
		1	2	3	4	5
					Goldendale Star Party	
6	7	8	9	10	11	12 Green-lake & Cromwell Star Parties
13	14 Columbus Day	15	16 SAS Meeting	17	18	19 Tele-scope Makers
20	21 Orionid Meteor Shower Peaks	22	23	24	25	26
27	28 SAS Board	29	30	31 Hallo-ween		

Minutes

HR, Puff, 'n' Stuff

By Greg Donohue

WE were fortunate to have as our speaker Dr. Douglas Downing, associate professor of economics at Seattle Pacific University and member of the SAS. Dr. Downing has a B.S. in economics and astronomy/physics, and a Ph.D. in economics, all from Yale. He teaches introductory astronomy at SPU. At the September general meeting, he discussed the Hertzsprung/Russell diagram, and how to model a star.

Building a stellar model lets us understand stars better, and testing the model against reality helps us to continually refine that understanding. We start with the only star with which we can get "up close and personal"—the Sun. We begin by collecting some observable facts about old Sol.

The distance from the Earth to the Sun is about 1.5×10^8 km. Historically, determining this distance was a bit tricky, involving the following steps: 1) Measure the maximum angle between Venus and the Sun. 2) Use geometry to find the *relative* sizes of the orbits of Venus and Earth. 3) Use very precise triangulation from different places on Earth to find the *absolute* distance to Venus as it transited the Sun. 4) Use this actual distance to turn the *relative* sizes of Venus' and Earth's orbits into *absolute* distances. These days, radar is used to measure the distance to Venus (step 3).

How about the size, or radius, of the Sun? The *angular* radius of the Sun can be measured directly. And since we already know how far away it is, simple trigonometry yields the Sun's *actual* radius, which turns out to be about 7×10^5 km.

Combining the distance to the Sun with observations about the Earth's orbit lets us determine the Sun's mass. The centripetal force for an object in a circular orbit is equal to the gravitational force: $F_{grav}=GM_{sun}m_{earth}/r_{orbit}^2$, and $F_{centrip}=a_{centrip}m_{earth}$.. For uniform circular motion: $a_{centrip} = v^2/r_{orbit}$, and $v = 2\pi r_{orbit}/T_{orbit}$ (where *v* is the speed, and *T* is the period). Setting $F_{grav} = F_{centrip}$ gives: $(m_{earth})(G M_{sun} / r_{orbit}^2) = (4\pi^2 r_{orbit} / T_{orbit}^2) (m_{earth})$. This can be rearranged to give Kepler's third law: $T_{orbit}^2 = (4\pi^2 / G M_{sun}) r_{orbit}^3$. Solving for the mass of the sun: $M_{sun} = (4\pi^2 r_{orbit}^3 / G T_{orbit}^2)$. Plugging in the radius and period of the Earth's orbit and G (the universal gravita-

(Continued on page 12)

Minutes *(Continued from page 10)*
tional constant $= 6.67\times10^{-11}\ m^3/kg\text{-}s^2$) yields a value for the Sun's mass of about 2×10^{30}kg.

What about the Sun's *luminosity* (that is, the amount of energy it gives off)? Assuming that the Sun energy output is spherically symmetrical (gives off equal energy in all directions), and knowing how much energy is received by a small area, we can extrapolate that over the total area to get a luminosity of around 3.9×10^{26} Watts.

Since the Sun is close to being a black-body (absorbs energy but does not reflect it), we can find its surface temperature by examining the light it emits. This turns out to be about 5,800K.

PUFF

Given this information, we can start to put together a basic model of the Sun. But because the Sun is a gaseous body with no solid surface, we are first faced with an important question: Why doesn't the Sun collapse under the force of its own enormous gravity? The only thing that could be stopping it is gas pressure. We also know that the Sun has been in balance—stayed about the same size—for an extremely long time. So some very long lasting phenomenon must be creating the monstrous gas pressure that just balances the Sun own inward gravitational pull. Only extremely high temperatures (much, much hotter than the surface temperature) can generate such pressure.

Using the model of the Sun, we find that the temperature goes up dramatically as you move inward, and the temperature in the core must be in the millions of Kelvin's. But since the Sun is radiating some much energy out into space, why isn't it cooling down?

A century ago, this was an unsolved mystery. But Einstein's famous $E=mc^2$ equation showing the equivalence of mass and energy, along with a growing understanding of nuclear processes finally provided the answer: Nuclear fusion of hydrogen into helium is what PUFFs the Sun up. This process generates high-energy gamma rays that would be lethal to us. But these photons are reabsorbed over and over again as they work their way toward the surface, finally to emerge as visible light. So our model must take into account this energy flow.

If we assume spherical symmetry, and ignore complications such as magnetism, rotation, and mass loss, we can create a simple solar model by solving a series of differential equations for four quantities as functions of the solar radius: pressure(r), mass(r) (or density (r)), temperature(r), and luminosity(r).

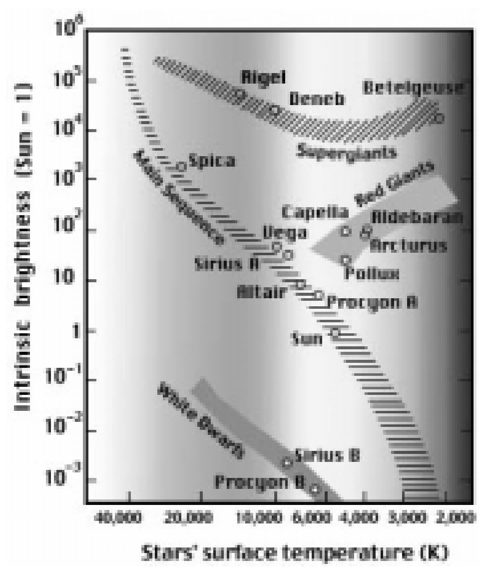
HR

This gives a pretty good model of the Sun. How about applying it to other stars? Hertzsprung and Russell came up with a diagram (the HR diagram) that compares the luminosity (absolute magnitude/brightness) of stars with their temperature (spectral class – OBAFGKM).

The band that runs from the upper left to the lower right is called the “main sequence”, since most stars fall is this area. All stars reside on the main sequence when they are burning hydrogen. Where it lies on the main sequence is a function of its mass. The more massive blue giants shine brightly, but exhaust their fuel quickly. Red dwarfs are dim, but last for perhaps a trillion years. Stars like our own Sun fall in the middle, shining modestly but lasting for billions of years.

‘n’ STUFF

Just as a star’s mass determines its place on the main sequence and the length of its life, so a star’s *final core mass* determines which of three ultimate fates its will meet.



If its final core mass is less than 1.4 solar masses (known as the Chandresakhar limit), the star is destined to end up as a white dwarf (lower left on HR diagram). The nuclear fusion has ceased in the core, so the star collapses until the electrons resist further

(Continued on page 14)

Minutes *(Continued from page 13)*
compression. A typical white dwarf compresses the mass of an entire star like our Sun into a volume about the size of the Earth.

Should the final core mass be greater than Chandresakhar's limit, but less than about 3 solar masses, the star ends up as a neutron star. The extra mass overcomes the electron's repulsion, forcing them to combine with protons to form neutrons. The star is, in effect, a single massive atomic nucleus. Just as the electrons resisted further compression, so do the neutrons, and it is this resistance that prevents even further collapse.

A white dwarf in a binary system might accrete additional mass from its companion star. What happens if through this accretion it finally exceeds Chandresakhar's 1.4 solar mass limit? Gravity will overcome the electron repulsion, and the star will quickly collapse toward becoming a neutron star. However, during this rapid collapse, the star's contraction actually overshoots the point where neutron repulsion occurs, and then "bounces back" violently, tearing the star apart in what is known as a Type I supernova. Since these Type I supernovae all occur under the same conditions—as a white dwarf just exceeds Chandresakhar's limit—they are nearly identical to each other, and can therefore be used as "standard candles" to measure distances to far away galaxies.

Above about 3 solar masses, even the neutron pressure can no longer resist gravity's inexorable crunch. No other known force is left to challenge gravity, so a star whose final core mass exceeds about 3 times that of our own Sun will succumb totally to gravity, becoming a singularity within a black hole.

Finally, returning to the HR diagram for a moment, plotting such diagrams for clusters of stars can give a good indication of the clusters' ages. Since blue giants are rare (because they burn out so quickly), if a star cluster's HR diagram has blue giants on its main sequence, the cluster must be relatively young. If, on the other hand, the main sequence of a cluster's HR plot is foreshortened due to the absence of blue giants, then it can be inferred that the cluster is relatively old.

Poo Poo Point Road Report

Due to unfavorable road conditions on Tiger Mountain, the monthly Poo Poo Point star party will be suspended until Spring 2003. During the Winter and next Spring, the road conditions will be re-evaluated and an announcement will be made concerning when the next event will be held.

Membership Information

Choose from the membership and subscription options listed and mail this form and your check to the address below. For family memberships, please include the names of persons you want to appear in the membership directory. For student memberships, please include verification of full-time student status (such as student ID card). For renewals, please attach magazine subscription renewal cards.

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