THE FLINT RIVER OBSERVER

NEWSLETTER OF THE FLINT RIVER ASTRONOMY CLUB

An Affiliate of the Astronomical League

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Please notify **Bill Warren** promptly if you have a change of home address, telephone no. or e-mail address, or if you fail to receive your monthly *Observer* or quarterly *Reflector* from the A. L.

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Club Calendar. Fri., Dec. 2: JKWMA observing (at dark); **Sat., Dec. 3rd:** Christmas party/dinner meeting (6:00 p.m. at Brian's (used to be Ryan's) Buffet Restaurant in Griffin.

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President's Message. Venci Krumov is the kind of new member that every astronomy club needs. Since joining FRAC last July, Venci has been a regular fixture at our meetings and observings. He comes early, stays late, and when there is work to be done he pitches in without being asked. To top it all off, he lives 75 mi. away in Columbus, so it's not like he's a hop, step and a jump away from us.

Unfortunately, Venci will be leaving us shortly after you read this. He will return to his native Bulgaria when his work here is finished in late November. He knew when he joined FRAC that he'd be leaving in a few months – he's a lawyer for a Bulgarian company that is building a couple of power plants near Columbus – but at our last JKWMA observing he extended his membership for four years.

We'll miss you, Venci. We wish you good luck, good health and happiness. You've made many new friends in your short time with us, and we won't forget you. Keep us posted about what you're doing in astronomy and astrophotography, and let us know how we can help you in the future.

-Dwight Harness

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Last Month's Meeting/Activities. The **Milligans – Jeremy, Sarah, Emily & Delilah –** recently visited another wildlife management area in the vicinity, Big Lazer Creek WMA. While there, Jeremy found a hilltop observing site with incredible horizons in all directions. It's located about 45 mi. from Griffin between Thomaston and Talbotton – too far away to be FRAC's primary observing site but certainly worth an occasional visit.

On Sat., Oct. 22nd, Jeremy met **Venci Krumov** at Big Lazer Creek to do some observing. Venci got to try out some astrophotography with his new 8-in. Astrograph Newtonian reflector. (See photo, p. 6.) They stayed late, and had a grand old time.

Venci returned alone to BLCWMA on Oct. 25th to look for a new nova in *Sagittarius.*

We had 13 members at our JKWMA observings on Oct. 28th-29th: **Dwight Harness, Venci Krumov & yr. editor** (both nights); **Aaron Calhoun, Erik Erikson & Carlos Flores** (Fri. night); and **Felix Luciano, Alan Pryor, Jeremy Milligan & Mike Stuart** (Sat. night). We saw the supernova (which gave yrs. truly the opportunity to quip, "It looks just like a star!"; Venci took photos both nights of the area where **Pluto** lurked – Pluto was the faint "star" that moved from one night to the next; some of the others took deep-sky astrophotos, and others took advantage of the clear nights to look for Messiers and other things; and it was a blast from the past to spend an evening observing with Mike after far too long an absence. (Mike, who has three A. L. pins, spent many an hour observing at Cox Field in years past.)

Nineteen members and a guest attended our Nov. 10 meeting to hear **Dr. Richard Schmude's** superlative talk on estimating the brightness of Venus: **Tom Moore; Steve Hollander; Dwight Harness; Venci Krumov; Alan Rutter; Kenneth & Rose Olsen; Felix Luciano; Truman Boyle; Carlos Flores; Angela Knight; Cynthia Armstrong** and her guest, **Sharon Janacek; Dan Pillatski; Jeremy, Sarah, Emily & Delilah Milligan**; and **yr. editor**. Alan became the 1st person in FRAC to earn a Hydrogen-Alpha Observing Program pin, and the club voted to donate $200 to **Stephen Ramsden**'s Charlie Bates Solar Outreach Project.

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This 'n That. From our "Better Late Than Never" Dept., here is charter member **John Wallace's** response to the *Should we send astronauts to **Mars**?* question:

"I think we should continue to work toward that goal. The technology and scientific knowledge it creates is immeasurable and benefits mankind in many ways.

"As your quote from **W. I. E. Gates** stated, we can't wait until we solve all our problems to send astronauts to Mars and other places. But I think we should proceed slowly and cautiously enough not to supersede problems such as adequate food production, the threat of diseases, and national security.

"Two things are certain: Mars is not going away any time soon, but our natural resources are. At some time in the future, we must go to other planets and moons in order to mine their resources -- and we must do so before our own resources are depleted to the point where it is no longer possible to sustain that effort.

"I just don't know how soon we must do this. Certainly we should proceed with caution."

*Reacting to **Felix Luciano's** recent photos (see p. 6), **Venci Krumov** wrote, "What Felix is doing is A-M-A-Z-I-N-G!...I'd need years to reach anywhere near what he's doing now. But that's my motivation."

*__Mars Trivia.__ Mt. Everest is the highest mountain on Earth, rising 29,028 ft. above sea level. But **Olympus Mons,** a martian volcano, is 2-1/2 times taller: it soars 13.6 mi. into the martian sky.

*Sunsets on Mars appear blue. Dust in the martian atmosphere allows light at the blue end of the spectrum to penetrate more efficiently than longer wave-length colors.

*If the Earth were the size of a quarter, Mars would be the size of a dime 100 yds. away.

**Earth has 3-1/2 times as much surface area as Mars; which planet has the most dry land?* (Ans.: Neither. They have the same amount of dry land because oceans cover 71% of Earth's surface.)

*It takes 687 days – 1.8 Earth-years – for Mars to complete one revolution around the **Sun**. If you were born on Mars, you'd be about half as old as you are now. But you also would have received only half as many birthday presents.

*The gravity on Mars is only 38% that of Earth. If you can slam-dunk a basketball on a 10-ft. goal here on Earth – fat chance of *that* happening! -- you'd be able to dunk on a 16-ft. goal on Mars. (And since the **Moon's** gravity is just 1/6th of Earth's, you'd be able to dunk on an 18-ft.-high lunar basketball goal.) Try *that*, **Lebron James**!

*The 2013 movie *Gravity* cost $100 million to film. That same year, India successfully sent a spacecraft into orbit around Mars for $74 million. Apparently, fiction is 26% more expensive than reality.

*When the *Sojourner* spacecraft landed on Mars in 1997, three men from Yemen sued NASA for trespassing, claiming they had inherited the Red Planet from ancestors who lived 3,000 years ago. Their suit was dismissed, not because they were knuckleheads or because they couldn't prove their claim or explain how their ancestors came to own Mars, but because in 1997 an international treaty ruled that Mars belongs to all mankind.

(**Prof. Stargazer** frowned and shook his head when we told him about it, saying "There are charlatans everywhere looking to make a quick buck. You have to be very careful in dealing with frauds like that.

"Fortunately, the people in my family have always been very honest. When my great-great-grandfather died, he left me the deed to **Venus** that he had inherited from his great-great-grandfather's great-great-grandfather, who was in fact an extraterrestrial from Venus.

"Due to recent financial setbacks, I'm forced to sell that priceless family heirloom. For just $125, you can be the proud owner of Earth's sister planet. I take Visa and Mastercard.")

What is the "Goldilocks zone"? It is a term applied to planets and exoplanets that, like the fairy tale about the three bears, are "not too hot and not too cold" to support life.

Although **Mars** and **Venus** may have been capable of supporting life forms larger than microbes at some earlier time in their existences, that is no longer the case. Technically, they are still in the Goldilocks zone, but conditions have changed since eons ago. Venus is too hot now, and it brings new meaning to the term acid rain – it rains sulfuric acid there – and Mars has no breatheable atmosphere. Neither of them contains free-standing water, and they do not have a magnetic field to protect them from solar radiation.

With the exception of Earth, of course, the other planets in our solar system lie outside the Goldilocks zone. **Mercury** is too close to the **Sun**, and the outer planets are too far away.

Presently, astronomers are searching for Earth-sized Goldilocks exoplanets orbiting other stars. They recently announced the discovery of an exoplanet, **Proxima Centauri b**, that is orbiting the closest star to the Sun. PCb is in the Goldilocks zone, but since only three things presently are known about it – its mass, orbital period and distance from **Proxima Centauri** – it's a tad too early to assume that life exists there. We don't know if PCb has a rocky surface to stand on like the three inner planets in our solar system do, or whether it has an atmosphere or water.

Just because the conditions may be right for life to arise somewhere doesn't mean it has occurred. It just indicates where we should look for it.

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Upcoming Meetings/Activities. We'll have one JKWMA observing this month, on **Fri., Dec. 2nd**.

At 6:00 p.m. on **Sat., Dec. 3rd,** we'll hold our annual Christmas party/dinner meeting at Brian's (it used to be Ryan's) Buffet Restaurant in Griffin. We'll have a bunch of door prizes to give away. These get-togethers are always a barrel of fun, and the food is better now than it was before the ownership changed hands. So bring the family, win some door prizes and leave with a full stomach and a smile on your face.

Directions to Brian's. Coming south from, say, Hampton on U. S. Hwy. 19/41, stay on the 4-lane past the Hardee's/McDonald's stoplight in Griffin. Go two stoplights farther and turn right. Brian's parking lot is on the immediate left, just beyond the movie sign.

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Another Look at Black Holes
article by Bill Warren

I'm fascinated by the power and complexity of black holes; that's why I write about them so often.

Most people outside astronomy know little or nothing about what's out there in the universe beyond our solar system – but they know about black holes, even if they don't understand them. At FRAC's indoor presentations, someone invariably asks a question about black holes. But that brings up three problems. First, since we cannot directly observe them, their existence remains a theory, not a fact. Second, there is probably a lot more that we don't know about black holes than what we *do* know. And third, much of what we know falls into the category of educated guesses.

Here's what we know.

What is a black hole? Basically, it is an object that is so massive and compact that nothing – not even light – can escape the gravity within it. Almost without exception, black holes are end products of stars that began life with a mass of 30 or more **Suns**. Such stars end their lives in a supernova explosion.

The Death of a Giant and the Birth of a Black Hole. Massive stars like **Betelgeuse** gradually expand into red giants in their old age, eventually reaching diameters of hundreds of millions of miles. When a red giant star explodes as a supernova, its outermost layers of gases are expelled in a single cataclysmic blast. Those gases eventually combine with other interstellar gases and material and form huge nebulous clouds in which new stars are born.

The inner layers of gases suffer a vastly different fate. Unable to support their weight after the star has run out of fuel, they implode – explode inward -- with a violence that is found nowhere else in the cosmos, creating a gravitational force that is virtually infinite. That implosion – and the gravity it produces – is so powerful that *nothing*, not even the photons that comprise light, can escape it. The black hole is black because the light from those inner layers of gases is absorbed *into* the black hole, not expelled from it. Without light emission, there is nothing to see.

Dissecting a Black Hole. Start with the obvious: No one knows what the interior of a black hole is like, since observable or detectable information vanishes forever when it enters the black hole. What follows is astronomers' best guesses as to what the interior might be like, based on predictions drawn from computer models and mathematics.

Black holes are thought to consist of three main parts: a core, or *singularity*; an *event horizon* that separates the black hole and its contents from nearby material that is affected by the black hole's gravity but has not yet been absorbed by it; and an *accretion disk* where that material awaits its fate.

The Singularity. Everything within a black hole immediately winds up at its center, or *singularity*. It is a bizarre place where the laws of physics that govern the rest of the universe do not apply.

Singularities are infinitely compact and dense. The compression is so great there that an entire galaxy of billions or trillions of stars would not only fit inside a black hole, but they would take up no space at all.

Space-time is nonexistent within a black hole. Time stands still at the black hole's outer boundary, and neither space nor time exist within the singularity. (That's *heavy* thinking, dudes and dudettes!)

The Event Horizon. Black holes are sometimes compared to cosmic vacuum cleaners. Like the vacuum cleaners we use in our homes, they draw in material only in their immediate area. When you're vacuuming a room, dirt and dust on the other side of the room is not affected by it. Black holes do not seek out material to ingest, they simply absorb whatever is in their path.

So black holes are not infinitely powerful attractors. They have their limits, which are defined by their outer boundary, or *event horizon*.

The event horizon separates the black hole's interior from the observable universe outside it. It is literally a "point of no return": once anything, whether it be light, gases, stars or even galaxies, is drawn into and beyond the event horizon, it cannot escape. It is gone forever, first stretched out like strands of spaghetti and then added to the singularity's mass.

Since that mass is compressed into an infinitely small area, the event horizon doesn't have to be very large. They vary in size, but a solar-mass black hole's event horizon is only a few tens of miles in diameter.

Outside the event horizon, however, life goes on as normally as it can in an area where an infinitely powerful implosion is taking place.

The Accretion Disk. Think of a sinkful of water from which the stopper has just been removed. The unseen drainpipe beneath the drain is the black hole, and the drain itself is the event horizon. Gravity is the force that draws water into the drain and down the drainpipe.

Obviously, not all of the water in the sink can enter the drain at once. The water nearest to the drain goes down the pipe, and the next-nearest water swirls around the drain, held there by gravity as it waits its turn to sink into it.

A black hole's *accretion disk* consists of whatever material is close enough to the black hole to be affected by its gravity. Initially, that material – let's use a star as an example -- contains sufficient energy to maintain a relatively stable but exceedingly rapid orbit around the event horizon. (Those abnormally rapid movements are one of the clues astronomers have that a black hole might be present. See below for other clues.)

Over time, however, as more and more of the star's gases and energy are stripped away by the black hole, its orbit becomes an inward death-spiral that ends when what is left of the star finally crosses the event horizon.

How do we know that black holes exist if we can't see them? We can't see inside a black hole –

but we *can* see the accretion disk that surrounds it, and we can study and measure the effects of the violent activity that is taking place there.

While a black hole does not immediately suck everything around it into itself, it exerts enough gravitational influence to keep material orbiting around it in the accretion disk.

As material builds up around the event horizon, collisions of particles in the accretion disk generate temperatures of millions of degrees. Those collisions produce radiation that is ejected in the form of jets streaming away from the black hole's polar axes. The jets can be detected as radio waves, gamma rays, X-rays and even light rays, and they can extend hundreds of thousands of light-years from the black hole. We can see those jets whenever they interact with interstellar gases around them, or when their streams are aimed directly at us like a laser pointer's beam. The jets increase in intensity whenever a particularly large and massive object such as a star is squeezed into the event horizon.

Alan Pryor's stunning photo (above) shows such a jet emanating from the accretion disk of a black hole at the center of the elliptical galaxy **M87** in *Virgo*. The jet appears as a small bluish streak extending from the galaxy's disk toward the upper left corner of Alan's photo. It stretches from M87's core all the way through the galaxy and beyond, a distance of at least 270,000 light-years.

In 1964, instruments aboard a rocket in flight revealed a mysterious area of powerful X-ray emissions in the constellation *Cygnus.* The source of those emissions was found to be in the vicinity of a very faint, stellar-mass binary star, **Cygnus X-1**. Astronomers believe that the source of those X-rays is a black hole near Cyg X-1's companion star that is stripping away gases from the companion's surface.

Astronomers also believe that most galaxies harbor one or more supermassive black holes at their cores. (The one at the **Milky Way's** core is known as **Sagittarius A*** [pronounced "A-star"].) The Cygnus X-1 black hole does not lie at a galaxy's core; as a result, it is one of our best sources for information about solar-mass black holes, which are extremely rare.

Why are supermassive black holes so often associated with galaxy cores? Because that's where the action is, galactically speaking. Stars are more tightly packed together there, and when a core star goes supernova there is more material nearby for a black hole to feed on.

Black holes arise when a red giant star goes supernova. They grow into supermassive black holes when they absorb other stars or merge with other black holes.

(Incidentally, black holes apparently can die, too, through a process of evaporation. In 1974, **Stephen Hawking** theorized that black holes actually release a form of radiation known as *blackbody radiation* – a.k.a. *Hawking radiation* -- thereby reducing the black hole's mass and energy. If a black hole no longer gains mass [i.e., if its accretion disk runs out of material], the black hole eventually will shrink out of existence.)

Conclusion. Supernova explosions and black holes are two of the most violent and powerful phenomena in the universe. The energy released in a supernova explosion is so great that, for a brief period, the light from the blast outshines the combined light from all of the other billions or trillions of stars in that galaxy. It's so bright that we can see it in our backyard telescopes from billions of light-years away. (FRAC members saw one – **SN 2014 J** – at JKWMA in Jan.-Feb., 2014. It was located in the galaxy **M82** in *Ursa Major*.)

On the other hand, the inward tug of gravity within a black hole's event horizon is so powerful that nothing – not even particles of light or the combined energy of billions of Suns – can escape it or tear it apart. Nothing in the universe can survive a journey into a black hole. (According to

Hawking's theory, blackbody radiation can escape, but it is created by the black hole itself.)

A final thought: Light travels at the rate of 186,000 mi. per second. According to the laws of physics, nothing can exceed the speed of light. Yet light cannot travel fast enough to escape a black hole. Therefore, in order to have any hope of escaping a black hole before becoming spaghettified once you crossed the event horizon, you'd have to go faster than the speed of light. But how much faster would you have to go?

Since the laws of physics break down inside a black hole, it's possible that you'd have to travel infinitely fast to escape its clutches. And that's impossible, of course. But so is everything else about black holes. That's what makes them so fascinating.

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Above: Orion Nebula (M42), with **M43** to its immediate left. (North is toward the left edge of **Vencislav Krumov's** lovely photo.) **M43** is actually part of Orion Nebula but separated from it in our view by dust between us and the nebula.

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Lower Left Corner: **DWBs 128 & 134** in the **Cygnus X** region. Photo by **Felix Luciano**. Says Felix, "**DWB 134** is at the top of the image; it shows a resemblance to the **Elephant Trunk Nebula. DWB 128** (left of center) shows a resemblance to that of an"E."

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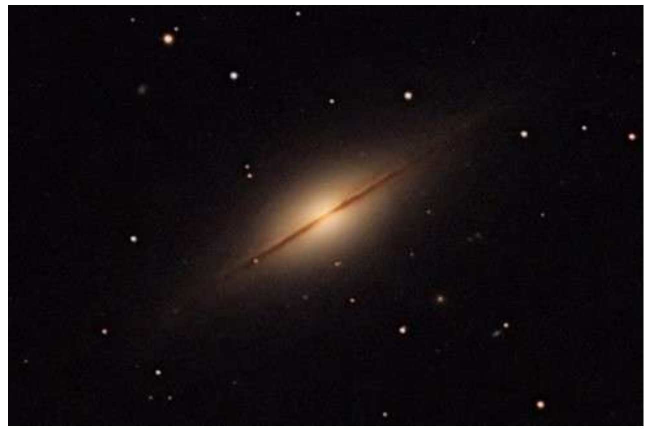

Above: NGC 7814, an edge-on spiral galaxy. Photo by **Alan Pryor**. At mag. 10.6, **NGC 7814** is one of the few bright galaxies in *Pegasus.* Visually, it presents a thickly oval core and hints of its dust lane. It is a Herschel II Program target, and #43 on **Sir Patrick Caldwell-Moore's** Caldwell list.

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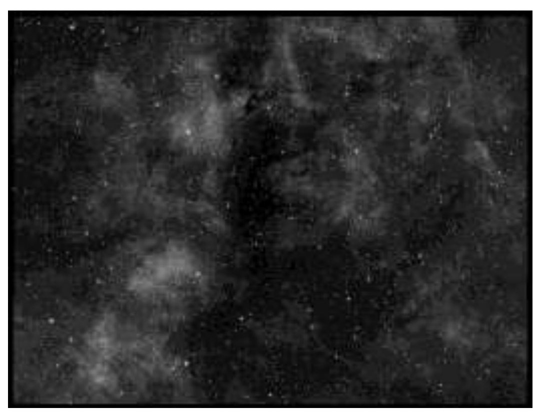

Above: **LBN 280**, "Another **Cygnus X** area of optically visible HII regions with lots of Ha emission and dust in the image." (**Felix Luciano**)

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