



The Refractor

The Bulletin of the Eastbay Astronomical Society
 Founded in 1924 at Chabot Observatory, Oakland, California

Volume 89
 Number 12
 September 2013

September 2013 Talk:

Speaker: Sona Hosseini

Subject: Khayyam: A Tunable Spatial Heterodyne Spectrometer for Broadband Observation of Diffuse Emission Line Targets

Saturday, September 14, 7:30 pm
 Chabot Space & Science Center
 Hauben Room, 2nd Floor, Spees Building

Have you ever wondered how it might be to develop a **tunable spatial heterodyne spectrometer** (TSHS) which could be used in the fixed focus of the Coudé Auxiliary Telescope (CAT) in the Shane Telescope at Lick Observatory (Khayyam)? Spatial heterodyne spectrometers are a class of interferometric* sensor capable of providing a combination of large *étendue* (range, scale, extent), high resolving power and wide field of view at optical and *NUV* (near ultra-violet) wavelengths in a compact format.

The TSHS addresses previously encountered problems using interferometers. The use of a single grating as both a dispersing and beam-splitting element in the all reflective SHS greatly relaxes the precision required in the alignment of the other optical elements relative to a more typical scanning Fourier Transform Spectrometer and allows the TSHS implementation to be accomplished with low cost commercial rotation stages.

Following completion of the ground based TSHS version (Khayyam), the longer term goals of the TSHS project are to provide in-flight testing on a sounding rocket platform that Sona's research group is developing, and then ultimately a translation to satellite applications.

**Interferometer: an instrument for measuring the angular separation of double stars or the diameter of giant stars by means of the interference phenomena of light emitted by these stars.*



Sona is a PhD student at the UC Davis, Dept of Engineering & Applied Science, and has been working on SHS technique for four years with her adviser Dr. Walter Harris. She is responsible for all aspects of a top-level instrumentation design and development from optical design to environmental stability, control, and data pipelining. First light was achieved in February 2012.

Since a long time ago, when I was 10-15 years old, I was fascinated by the idea of designing, building my own astronomical instrument and doing science with it... and here I am! I'm designing, building my own instrument (a Spatial Heterodyne Spectrometer) and I'll be studying comets with it for my PhD research. ☆

DINNER WITH THE SPEAKER

5:30pm

Saturday, Sep 14

Hunan Yuan

4100 Redwood Rd

(next to Safeway)

No need to confirm.

Just show up!

Inside This Issue:

Dark Energy	2
News 'n Views	3

Size Does Matter, But So Does Dark Energy

By Dr. Ethan Siegel

Here in our own galactic backyard, the Milky Way contains some 200-400 billion stars, and that's not even the biggest galaxy in our own local group. Andromeda

(M31) is even bigger and more massive than we are, made up of around a *trillion* stars!

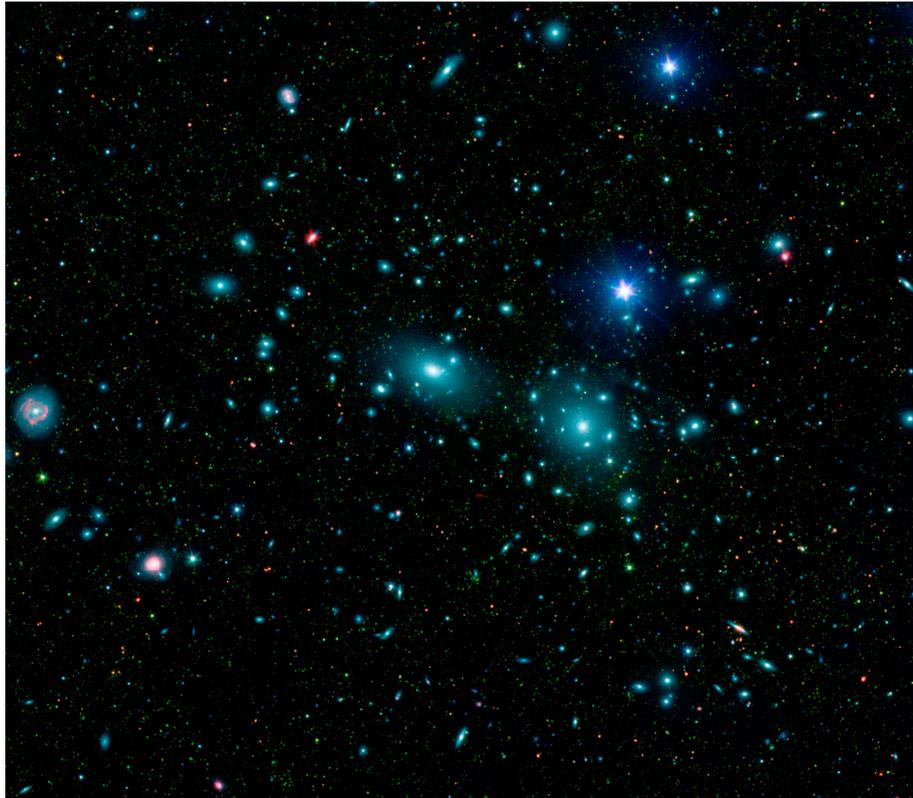
When you throw in the Triangulum Galaxy (M33), the Large and Small Magellanic Clouds, and the dozens of dwarf galaxies and hundreds of globular clusters gravitationally bound to us and our nearest neighbors, our local group sure does seem impressive.

Yet that's just chicken feed compared to the largest structures in the universe. Giant clusters and superclusters of galaxies, containing thou-

sands of times the mass of our entire local group, can be found omnidirectionally with telescope surveys. Perhaps the two most famous examples are the nearby Virgo Cluster and the somewhat more distant Coma Supercluster, the latter containing more than 3,000 galaxies. There are millions of giant clusters like this in our observable universe, and the gravitational forces at play are absolutely tremendous: there are literally *quadrillions* of times the mass of our Sun in these systems.

The largest superclusters line up along filaments, forming a great cosmic web of structure with huge intergalactic voids in between the galaxy-rich regions. These galaxy filaments span anywhere from hundreds of millions of light-years all the way up to more than a *billion* light

years in length. The CfA2 Great Wall, the Sloan Great Wall, and most recently, the Huge-LQG (Large Quasar Group) are the largest known ones, with the Huge-LQG -- a group of at least 73 quasars -- apparently stretching nearly 4 billion light years in its longest direction: more than 5% of the observable universe! With more mass than a million Milky Way galaxies in there, this structure is a puzzle for cosmology.

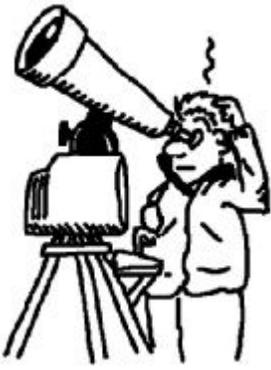


Digital mosaic of infrared light (courtesy of Spitzer) and visible light (SDSS) of the Coma Cluster, the largest member of the Coma Supercluster. Image credit: NASA / JPL-Caltech / Goddard Space Flight Center / Sloan Digital Sky Survey.

You see, with the normal matter, dark matter, and dark energy in our universe, there's an upper limit to the size of gravitationally bound filaments that should form. The Huge-LQG, if real, is more than *double* the size of that largest predicted structure, and this could cast doubts on the core principle of cosmology: that on the largest scales, the universe is roughly uniform everywhere. But this might not pose a problem at all, thanks to an unlikely culprit: **dark energy**. Just as the local group is part of the Virgo Supercluster

but recedes from it, and the Leo Cluster -- a large member of the Coma Supercluster -- is accelerating away from Coma, it's conceivable that the Huge-LQG isn't a single, bound structure at all, but will eventually be driven apart by dark energy. Either way, we're just a tiny drop in the vast cosmic ocean, on the outskirts of its rich, yet barely fathomable depths. ★

Learn about the many ways in which NASA strives to uncover the mysteries of the universe: <http://science.nasa.gov/astrophysics/>. Kids can make their own clusters of galaxies by checking out The Space Place's fun galactic mobile activity: <http://spaceplace.nasa.gov/galactic-mobile/>



Don's News 'n Views

Howdy Astro Fans! I hope you've had a fun, star-filled summer, even despite the short nights and the soon-to-end (as longtime club member and Chabot telescope deck volunteer **Alan Fisher** likes to say) *Daylight Squandering Time*

(Sunday, November 3, at 02:00 DST). But, it's already getting darker, earlier, and I, for one, appreciate it. The sad news is: this is the end of the 2013 Season of Saturn. This year, Saturn looked just like all those glow-in-the-dark stickers you can often find on children's ceilings—a classic view of the rings tilted down in front with still a bit of the planet's lower-half peeking out from under the rings. We won't begin to see Saturn again until the wee hours of Feb, 2014.

Did you catch this year's Perseid Meteor Shower? I heard it was a good one :-). The shower's date coincided with our August MOVN event (Member Only View Night), and Chabot had arranged with our volunteers to keep the telescopes open an extra four hours until 02:00. Unfortunately, we got fogged-out early on, so we didn't see nuthin', Demitol.

I've been busy! I'm kind of a constellation nut, and Chabot decided they'd like to start doing live, outdoor presentations of star stories that they're calling (strangely enough) *Star Stories*, which I was asked to produce. We started doing them in July, it was advertised in a couple of local parent magazines, and walla-walla! Every one of the five done so far have been sold out; I've been the presenter for four of them, and EAS member **George Shapiro** has done one (so far). Also, I (temporarily?) took over administering the *Barcroft High-Altitude Star Party* for this year from our be-

loved AstroWizard **Dave Rodrigues**, who has been setting up the BHASP since forever, but was somewhat busy this last year. By the time you read this, it will have been done and

over, and I've arranged for at least a couple of the participants to write us some descriptions and share some shots of how it went. Pictures and stories from ~12,450' above sea level are always a treat, so keep a weather eye out in next month's newsletter.



View of Pier 15 (off to the left) and the incomparable SF skyline from the Exploratorium's Bay Observatory Gallery

And, besides all that, Chabot's Volunteer Coordinator **Megan Steinwedel** set up a free group visit for CSSC volunteers to *The Exploratorium* at their new location (Pier 15 along the San Francisco Embarcadero waterfront). It was amazing. I have to admit to a little facility-envy. They spent multiples millions of more money just retrofitting the pier for earthquake safety than Chabot did for their entire facility, and then spent multiple millions more for their building and exhibits. They even had the *nerve* to take an exhibit component that Chabot wasn't using (a humongous rectangular convex mirror) and turned it into a cool display all by itself. I spent 5.5 hours there and estimate I saw maybe *half* of the exhibits. Maybe. If you ever decide to check it out (and I grudgingly recommend you do), go early, wear comfortable walking shoes, and you're probably best going via BART, as the parking around there is pretty expensive. Oh, one other recommendation: if you stay late, take a walk along the Embarcadero at night and look at the Bay Bridge's recently installed digital light display—it's really quite nice.

That's it for now! ★

◀ *Smokey clouds from the Mt. Diablo fire and a beautiful conjunction with the Moon and Venus as viewed from Rachel's west-facing window during the Sept MOVN.*



Mirror formerly used in a Chabot exhibit





Eastbay Astronomical Society

At Chabot Space & Science Center
10000 Skyline Boulevard ● Oakland, CA 94619

September 2013
RETURN SERVICE REQUESTED

It's Renewal Time!

If you've enjoyed being a part of the Eastbay Astronomical Society and supporting our mission to bring our love of astronomy to the public, please consider continuing your membership into 2014 and/or beyond! Thanks for being with us this year, and we hope to see you again, next year.

Eastbay Astronomical Society

President: Rod Simmons

Treas: Richard Ozer (510) 406-1914

Secretary: Don Saito (510) 301-2570

steel.blue.rod@gmail.com

rozer@pacbell.net

donsaito@yahoo.com

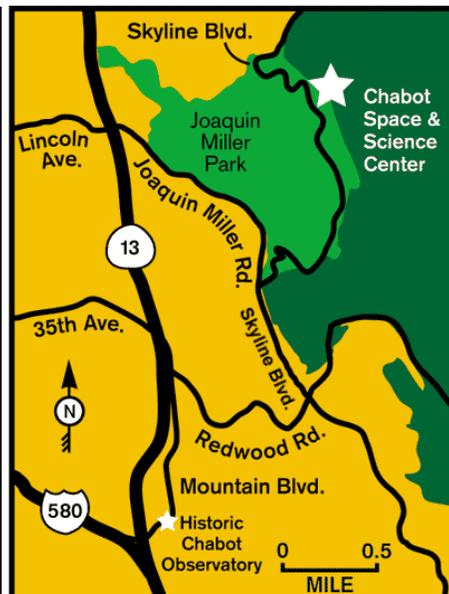
Vice President: Linda Lazzaretti - (510) 633-2488

Membership Reg: Rod Simmons - steel.blue.rod@gmail.com

Events Coord: David Prosper (510) 457-8346 - david_prosper@gmail.com

Articles and photos for *The Refractor* are encouraged. Deadline for the October 2013 issue is September 30, 2013. Items may be submitted to:

Editor - Navi Sandhu, 840 Villa Ave, Apt 22, San Jose, CA 95126. Email address: NavbalsinderSandhu@gmail.com HM: (408)-705-7417



FUTURE CONJUNCTIONS

- Sep 12 Board Meeting, Chabot, Library, 7:30pm
- 14 EAS General Meeting, Soda Bd Rm, 7:30pm - 10pm
- Oct 10 Board Meeting, Chabot, Soda Board Rm, 7:30pm
- 6 EAS MOVN, Wightman Plaza 7:30pm—10pm*
- 19 EAS General Meeting, Hauben Rm, 7:30pm - 10pm

*Always call Gerald McKeegan (925) 926-0853 to confirm

Join the Eastbay Astronomical Society

- Regular, \$24/year Family, \$36/year
- Contributing, \$40/year Student, \$15/year
- Sustaining, \$60/year or more

Contact: Richard Ozer, EAS Treasurer

Telephone: (510) 532-5477 Email: rozer@pacbell.net

Mail: PO Box 18635, Oakland, CA 94619-0635

Sign up online at <http://www.eastbayastro.org/>