Laboratory for Space Research

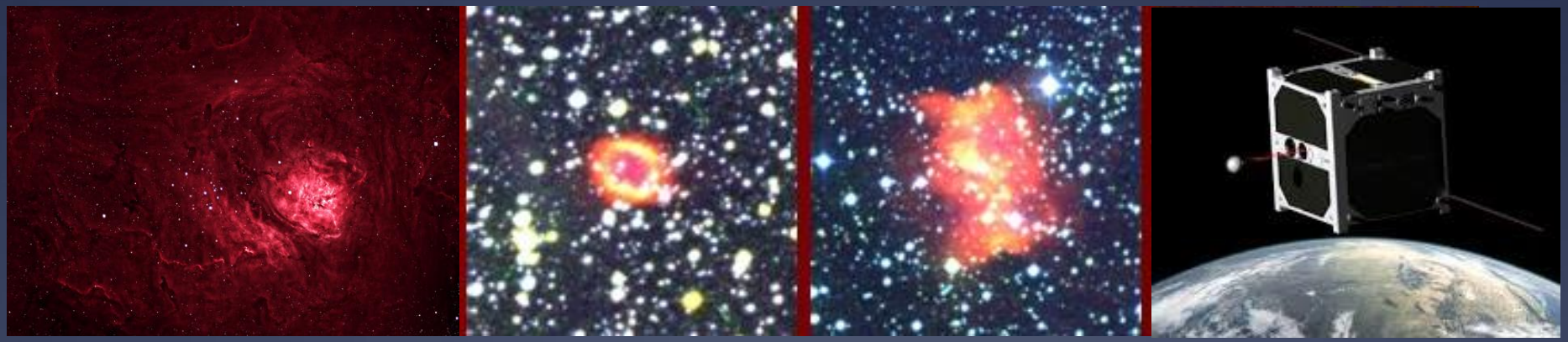
Department of Physics
The University of Hong Kong

PHYS3999/4999

i) The Galactic Graveyard and the Ultimate fate of our sun

ii) The astrophysics of Gaseous nebulae

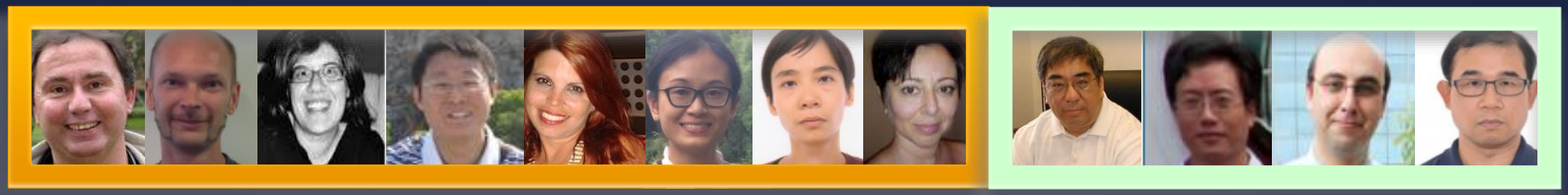
iii) Interdisciplinary/inter-university project for a novel cubesat mission



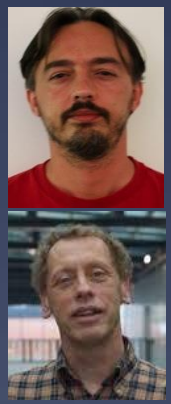
Prof. Quentin A Parker

Director LSR, Assoc.Dean (Global) FoS

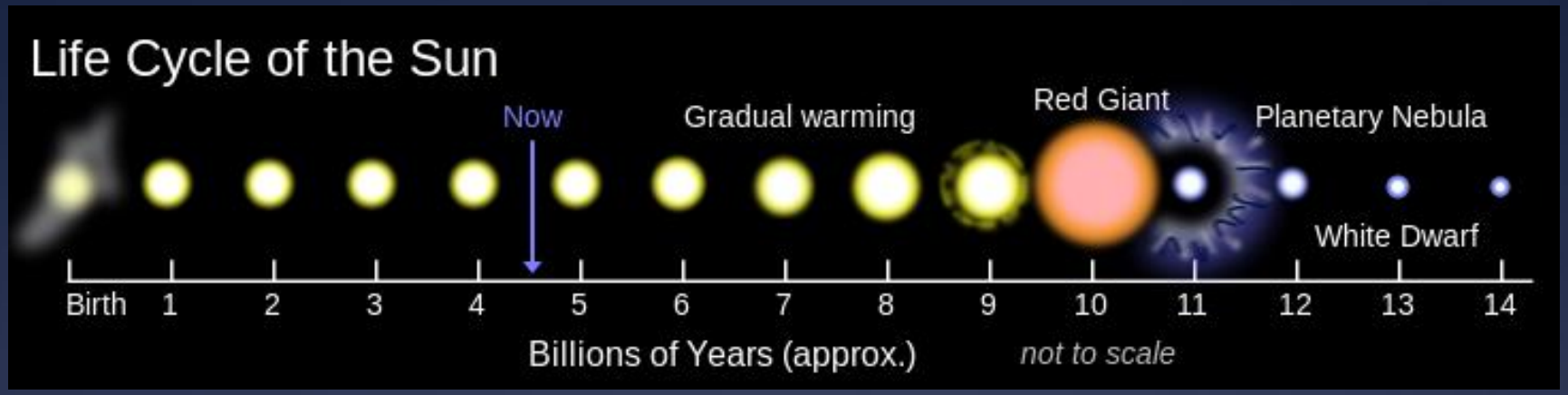
The HKU Late Stage Stellar evolution research group



- QAP established one of strongest PN research groups 2000-2015 at AAO/MQ → HKU 2018 "SciVal" indicates 8th strongest globally
- Core members moved to HKU in 2015 with QAP where an existing strong team was present under Prof. Sun Kwok
- New HKU group is 12 strong (QAP +SK groups)!
- 3 new PhD students recruited – more posts available + 3 postdocs (Drs Lykou, Ritter and Fang)
- Prof. A.Zijlstra Hung Hung Ying distinguished visiting professor also appointed for 5 years (2016-2021) allows 3 months/year
- Any student for these projects will be embedded in this team and be working at the LSR in Cyberport (see www.lsr.hku.hk)

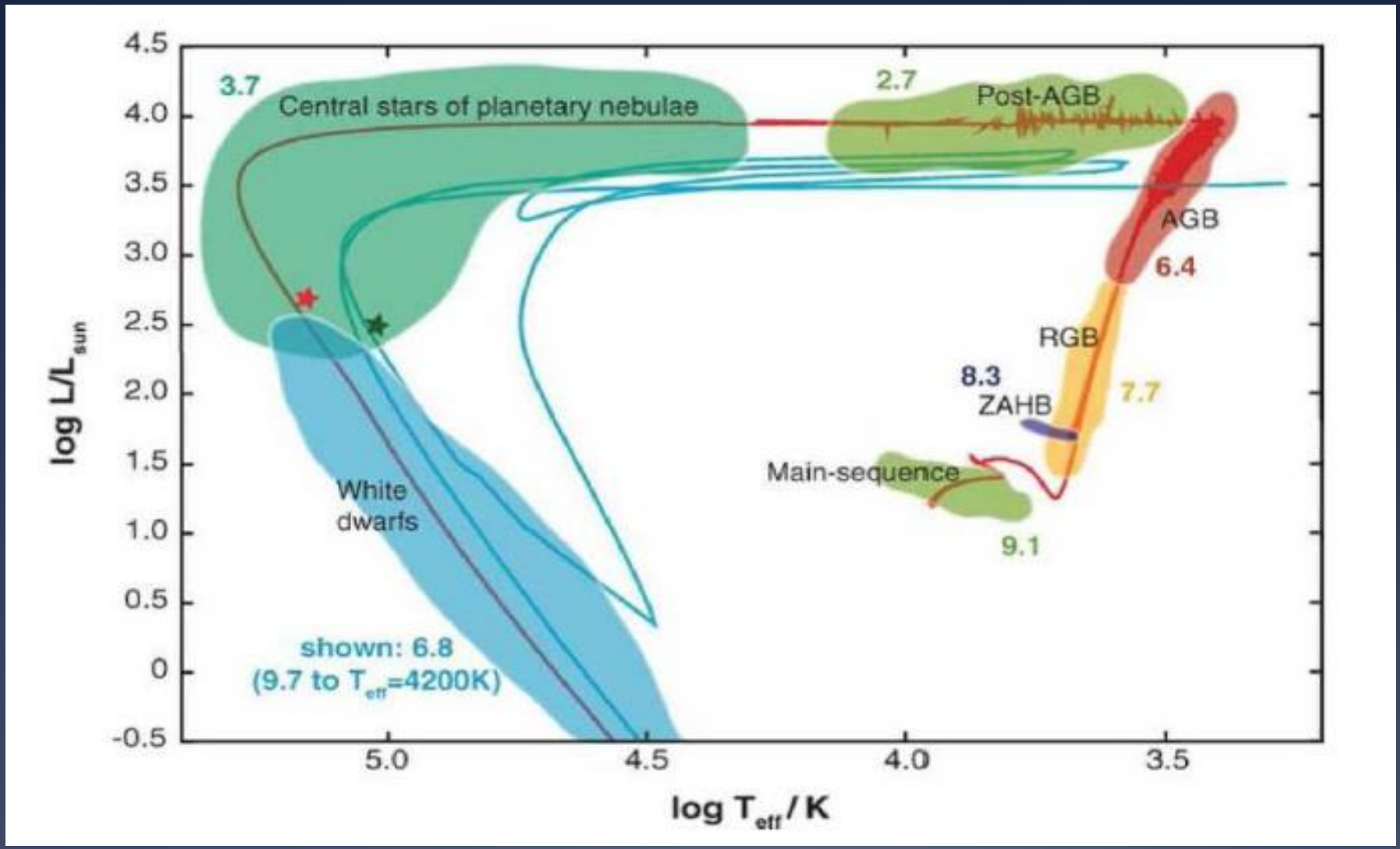


The likely Fate of Our Sun



- At its largest, the Sun may even gobble up our Earth.
- At its brightest
  - the red-giant Sun will be several thousand times more luminous than today
  - Its surface will be at about half the temperature now.
- Eventually, it will collapse into a white dwarf and fizzle out……
- BUT NOT before it has passed through the so called PLANETARY NEBULAE PHASE

EVOLUTION OF 2.5Msun star



- PN are among the most complex, varied and fascinating of celestial phenomena….well I think so..

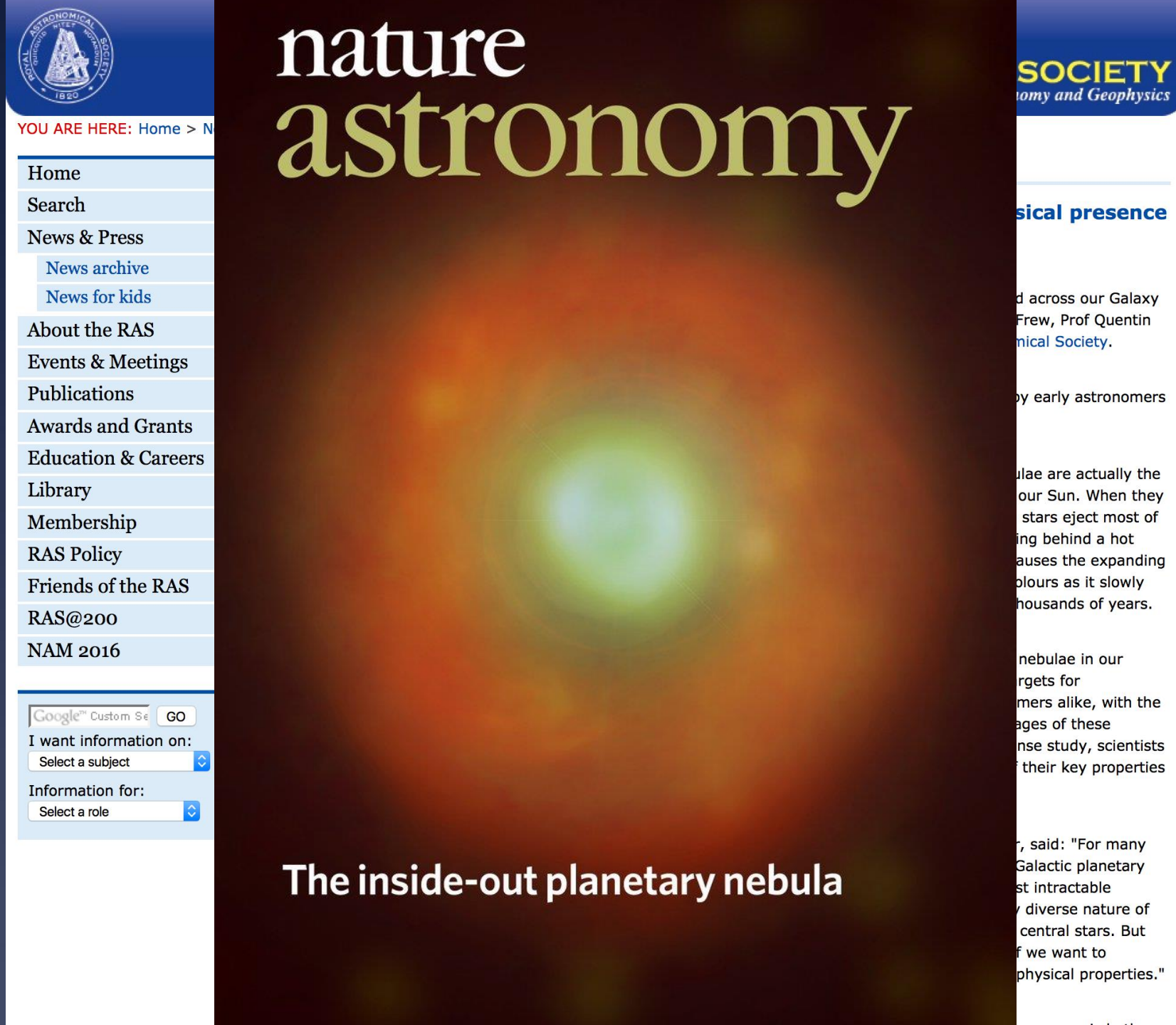
- Nothing to do with planets – just resembled them to early observers!
- They are what awaits our own sun in the distant future!... +4billion years ☺

- Formed when red giant stars eject their outer layers as clouds of luminescent gas and reveal the central, remnant white dwarf
  - → The evolutionary path taken by 95% of all stars in our Galaxy!

- They are also vital probes of:
  - nucleosynthesis processes (element building) ; abundance gradients
  - chemical enrichment of the interstellar medium via huge mass loss

- PN also act as powerful tracers of our Galaxy's star-forming history and are useful kinematical probes visible to large Galactic distances due to their rich emission line spectrum.

- These scientific drivers motivate the search for and study of PNe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First confirmed CORNISH PN (using the power of H*A*S*H)

HASH PN Database4.5 / PN Info / PNG 012.3-00.1

qparker

Department of Physics
The University of Hong Kong

F2BP 1

PNG	PNG 012.3-00.1
Status	True PN
Morph.	E
Diam.	na
Cat.	CornishCandidates
dbID	23902

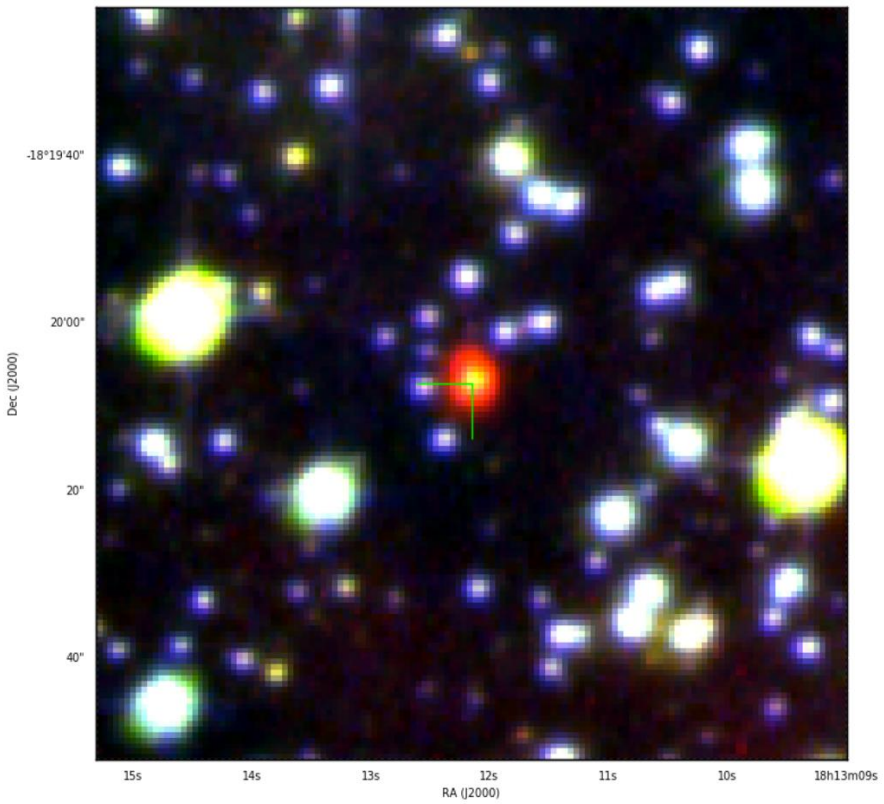
Centroid Coords

RA/DEC	18:13:12.15 -18:20:07.31
α/δ	273.3006 -18.3354
l/b	12.3314 -0.1807

Central Star Coords

RA/DEC	NA

Gallery | Fits Files | Spectra | Notes | Basic Data | General Data | Full Data



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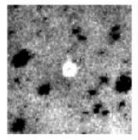
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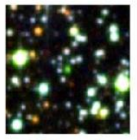
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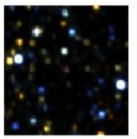
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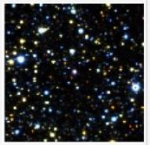
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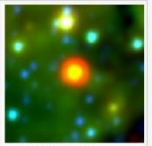
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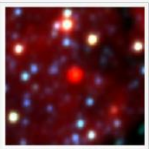
WISE321

nvss

1 | 2 | Next ›

Overlays

- Centroid / centroid.reg
- CS position / cspos.reg
- Diameter / diam.reg

SHS

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G:	sr.fits 3	97	%
B:	b.fits 3	97	%

Can click on spectra tab

MASPN Database4.0 / PN Info / PNG 212.6-00.0 qparker Department of Physics The University of Hong Kong

PHR J0650+0013

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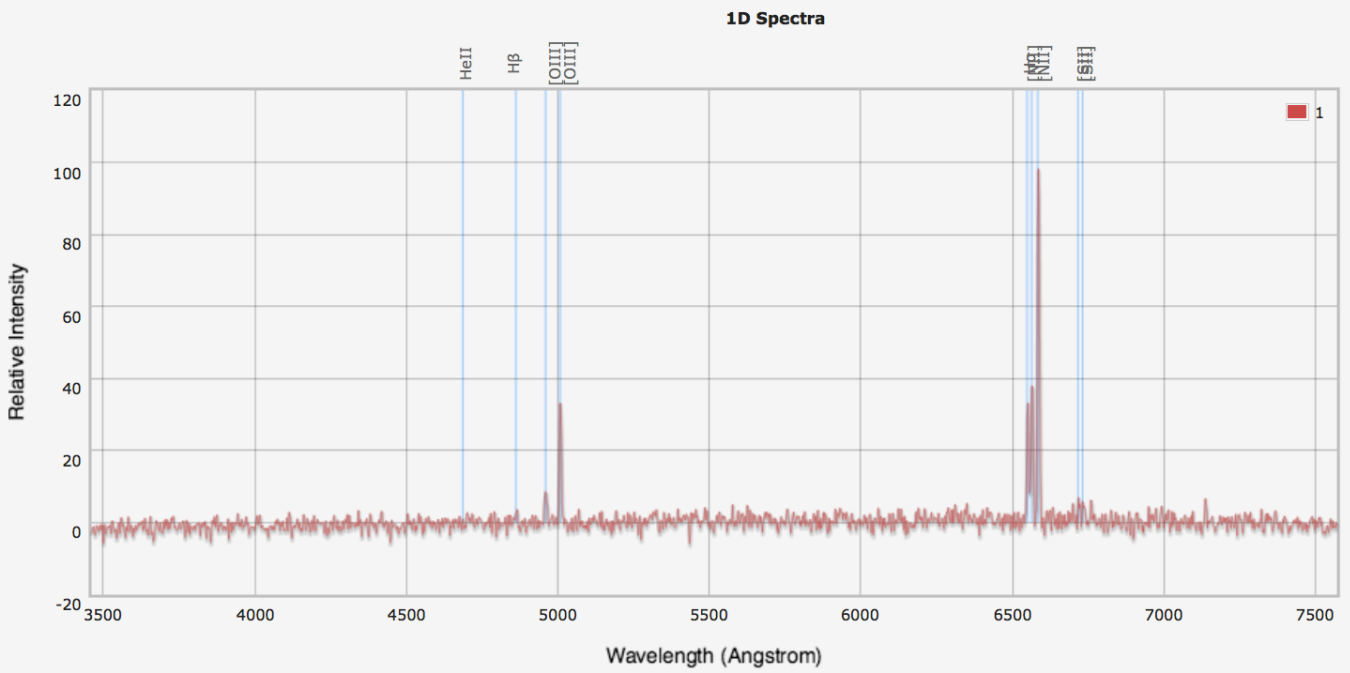

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[MgI]	4571
HeII	4686
[ArIV]	4740
Hβ	4861
HeI	4922
[OIII]	4959
[OIII]	5007
[NI]	5199
HeII	5412
[ClIII]	5518
[ClIII]	5538
[OI]	5577

Make Default

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☐	3	2006MNRAS.373...7...	PHR0650+0013NF_...	SAAO 1.9m;SAAO / ...	2004-02-12	3460 - 7570	no

Literature Spectra

Add record

PN as potent astrophysical tools

- PN formation rate → death rate of old, lower mass stars → directly probe Galactic stellar and chemical evolution.
- Complex morphologies → clues to formation, evolution, mass-loss processes, shaping role played by magnetic fields, binary central stars or massive planets!
- PN integrated flux, surface brightness and radius change in ways that can be predicted by current stellar and hydrodynamic theory.
- PN luminosity function is a key extragalactic distance calibrator (standard candles)
- At HKU we access some of the world's most powerful facilities to pursue our PN research including the recent award of time on the HST, ESO VLT and Magellan 8m class telescopes!

HASH ongoing project plans

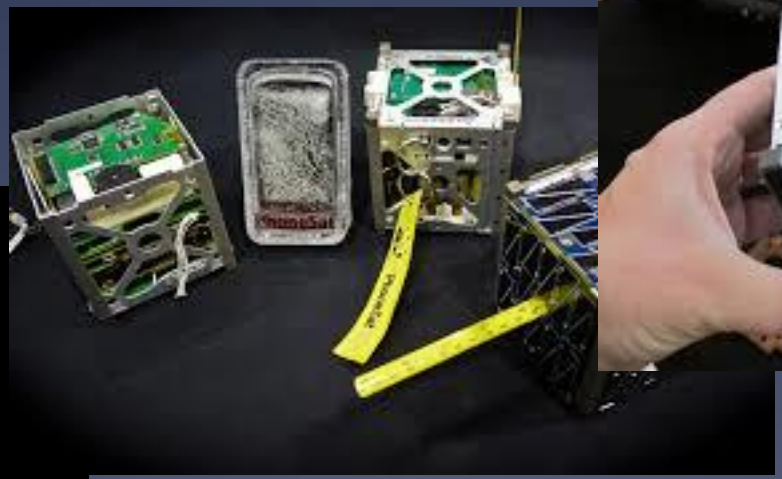
- Elimination of interlopers and construction of clean volume-limited samples to faint luminosities - can then derive accurate PN space densities and birth rates → for extremely low SB candidates this will rely on IFU observations
- Derivation of reliable and accurate distances to a large sample of "pure" Galactic PN using our new empirical SB-r relation technique - enables derivation of fundamental parameters (mass, size, temperature) for large numbers of Galactic PN.
- Use our more complete PN luminosity distributions local volume, Galactic Bulge to investigate nature of the high-luminosity cut-off. - cut-off underpins use of PN as a key cosmological distance indicator
- Investigate differences in PN multi-wavelength characteristics (e.g. Cohen et al 2010) - relate these to PN age, type and chemistry, derive mass-loss estimates and other key PN physical parameters → helps to understand their role in the chemical evolution of our Galaxy

- STUDENTS enrolled in my PHYS3999/4999 projects can be directly involved in and contribute to the above and related HASH based research over a semester

NEXT TOPIC

An Interdisciplinary and inter-university student project for a novel cubesat mission.

You may have heard that HKU is launching a satellite hopefully before the end of this year With NJU…….



Instrument

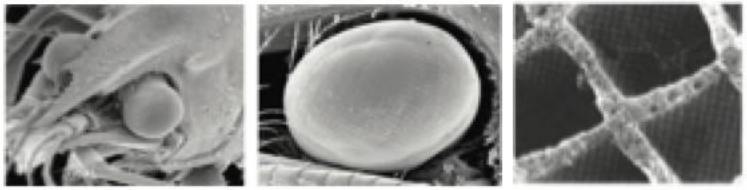


Fig.6 The real lobster eye and the surface details (Rene Hudec, 2010)

Lobster-eye X-ray telescope is a **new optical configuration** for imaging X-ray telescope, which is similar to the reflective eyes of macruran crustaceans such as lobster (J.R.P. Angel, 1979).

However, due to **difficulty of fabrication**, it has been not applied in astronomy field until now. HKU NO.1 will be the **first** space satellite using this technology worldwide.

This kind of telescope has **two main advantages**:

- **Wide field of view** (FoV): due to its spherical symmetry, any preferred axis along with off-axis aberrations can be removed, and the FoV can be as large as desired.
- **Low weight**: resulted from many small tubes of square cross section, the lower weight contributes to lower cost and more stable quality.

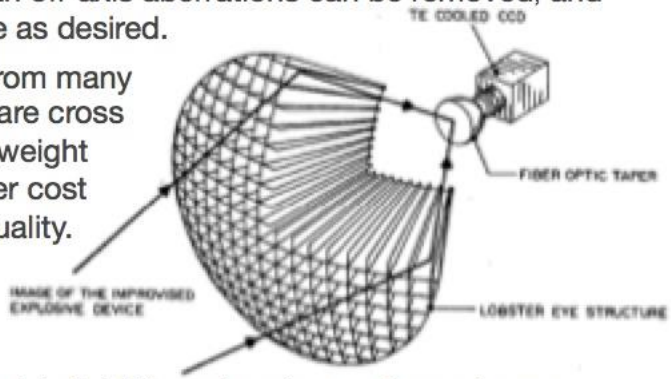


Fig.7 Lobster-eye wide field X-ray imaging system schema (Michael Gertsenshteyn et al., 2007)

Back to Media Home

The Laboratory for Space Research (LSR) of The University of Hong Kong, announces its plan to immediately establish a new LSR at HKU Zhejiang Institute of Research Innovation (HKU-ZIRI) in the Lin'an district of Hangzhou in Zhejiang province. With a strategic investment of HKD 10 million, the laboratory is designed to help put Space and Planetary Sciences and related activities squarely on the map at HKU.

Interdisciplinary teams

* In this project Physics students will form small, interdisciplinary teams with Engineering students to generate novel and feasible high-tech design and science payload for a joint HKU-ZJU "cubesat" mission

a "cubesat" is a small micro-satellite composed of 10x10x10cm units
CubeSats have a mass of no more than 1.33 kilograms per unit, and often use commercial off-the-shelf components, e.g. for their electronics

Inter-university collaboration

- Cross-faculty teams would compete within and between HKU and Zhejiang University to generate a cubesat proposal that could be chosen for actual launch into space under the MoU and co-funding agreement between the HKU Laboratory for Space Research
- (see www.lsr.hku.hk/)
- and the Zhejiang University microsatellites research group (see: www.hku.hk/press/press-releases/detail/18534.html).

Experiential learning opportunity

- Physics students would concentrate mainly on the science payload that could be accommodated in the cubesat
- However all students can contribute to any aspect of the project as teams brain-storm, design, engineer and devise feasible cubesat missions and their science payload
- This cubesat mission would address all the technology, engineering, electronic, communication, telemetry and control aspects of up to a "3U" cubesat with a payload that can deliver a meaningful science mission
- There is scope for some students to be members of ZJU teams (and vice-versa) so fulfilling at the HKU end **a Mainland experiential learning requirement**
- As said a "winning design" has prospects for actual launch into space!
-