

# 中子还是奇子： ——多信使天文一例

Renxin Xu (徐仁新)<sup>1,2</sup>

<sup>1</sup>School of Physics, <sup>2</sup>KIAA; PKU

(北京大学物理学院)

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# A key to all (PSR/SNE/GRB/FRB...): what's CBM?

- **What** if normal baryonic matter is *compressed*?

Normal matter is squeezed so great that 2-flavoured nuclei come in close contact during a supernova!



# 提 纲

- 什么是奇子? —— 一张路线图
- 可能有哪些多信使事件?
- 小结

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## 什么是奇子? —— 一张路线图



Wellcome to Neutron Star

Strangeon Star



NEUTRON STAR



Kill Electrons

STRANGE STAR

Strange Quark Star



2-flavoured

3-flavoured

PARK of Gravity-CBM

the park of gravity-compressed baryonic matter



# 为何要奇异？

Hobby

- Nature may love a state with flavor-maximization...

For strong matter around the *nuclear density*, the separation between quarks,  $\Delta\ell$ , could be  $\sim 0.5$  fm, determined by  $\alpha_s$ !

From Heisenberg's uncertainty relation,  $\Delta\ell \cdot \Delta p \approx \hbar$ , one may have an energy scale for strong matter,  $E_{\text{scale}}$ ,

~~(c,b,t)~~

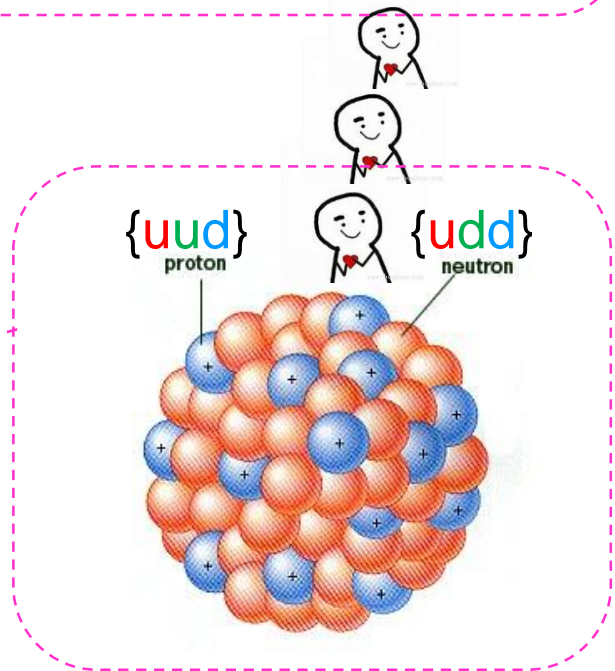
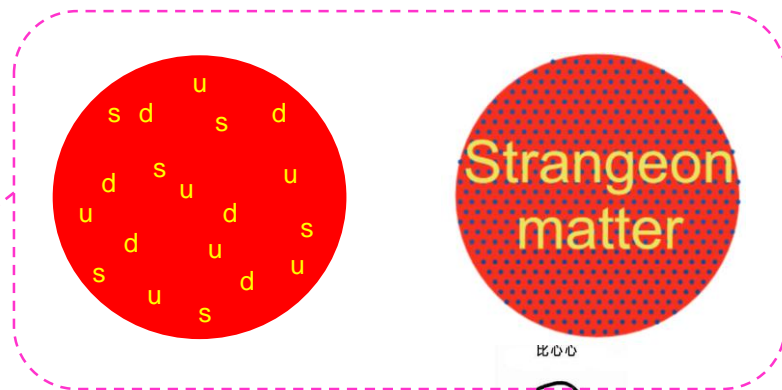
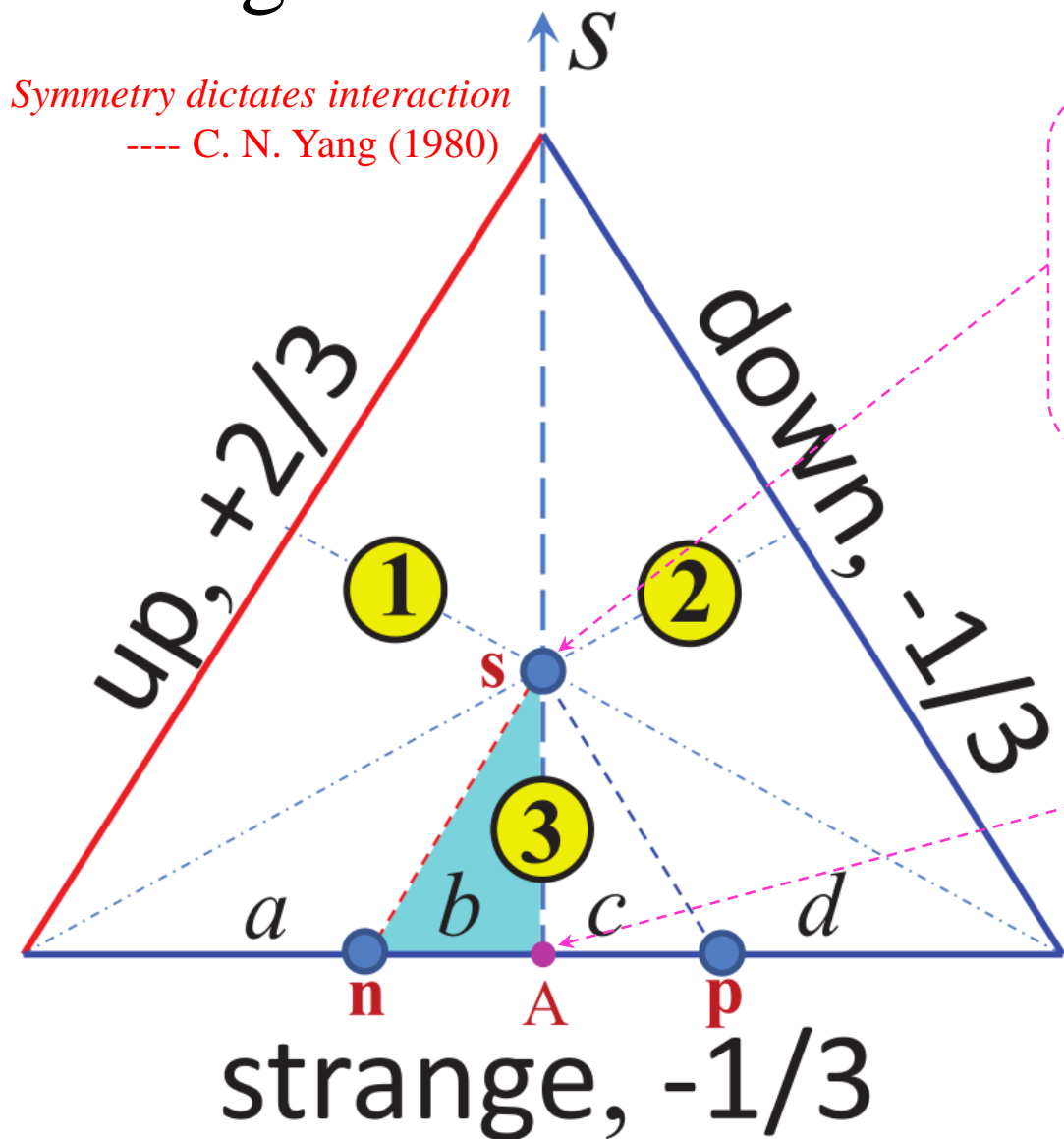
$$E_{\text{scale}} \approx \hbar c / \Delta\ell \approx 0.2 \text{ GeV} \cdot \text{fm} / 0.5 \text{ fm} = 0.4 \text{ GeV}.$$

*Note that...* we may expect 3-flavored strong matter because

$$\Delta m_{\text{uds}} \equiv (m_s - m_{\text{ud}})c^2 \ll E_{\text{scale}} < \Lambda_{\text{pQCD}}!$$

# 三味三角形

- Strong matter at  $P = 0$ : nucleons? *or* others?



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**可能有哪些多信使事件？**



# 仅电磁信号的可能证据

- **focus:** evidence model-dependent in astrophysics

	Peculiarity	Manifestation	Mechanism	Ref.
surface	binding energy.	<i>drifting subpulse</i> , $\mu$ structure	gap sparking in RS75	Xu et al. (1999), Yu & Xu (2011)
		clean fireball for SNE/SGR	photon-driven explosion	Chen et al. (2007), Dai et al. (2011)
	self-bound	mass as low as $\sim 10^{-2}M_{\odot}$	bound not by gravity	Xu & Wu (2003), Xu (2005)
	none-atomic X	Plankian radiation of X-ray	no-atmosphere if bare	Xu (2002)
		absorption in thermal spec.	hydromagnetic oscillation	Xu et al. (2012)
	strangeness bar.	low-z emission, type-I XRB	$2f$ matter separated from $3f$	Xu (2014)
optical/UV exce. of XDINS		bremsstrahlung radiation	Wang et al. (17/18)	
global	stiff EoS, $\Lambda$	<b>high <math>M_{\max}</math> (<math>2\sim 3M_{\odot}</math>)</b>	NR strangeons, hard core	Lai et al. (09ab, 18) Guo et al. (2014)
	anisotropic $P$	SGR/AXP's burst and flare	quake-induced ener. release	Xu et al.'06, Zhou et al.'14, Lin et al.'16
	rigidity	precession, GW radiation	solid, mountain building	Xu (2003) Xu (2006)

中子?奇子?

<http://faculty.pku.edu.cn/xurenxin/>

徐仁新

# 多信使时代的GECAM?

- 脉冲星glitch: R, H; GW
- X射线暴/X射线脉冲星: 暴发与计时, 及关联
- AXP/SGR的暴发: R, H; GW (1935? )
- 核心塌缩型超新星: O, H; GW;  $\nu$  (LGRB)
- NS-NS或NS-BH并合: O, H; GW;  $\nu$  (sGRB/FRB)

大量理论研究工作尚需完善, 以便弄清CBM到底是中子星还是奇子星!

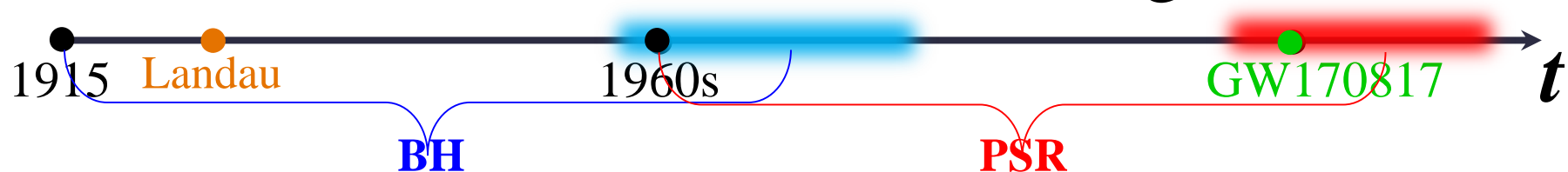
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## 小 结

# 小结

- **BH** astrophysics was active, but it is a golden era of **NS/PSR** with multi-messenger astron.:



...to be answered if GR is reliable!

- The basic units inside pulsar-like stars could be **3-flavour *symmetric strangeons*** rather than **2-flavour *asymmetric nucleons*** if the Nature really loves symmetry when building the world.
- To test the model with GECAM... **THANKS!**