Manuutsuguunimyawa miistsk Abduuxbiisii o?bigimskAAsts: bugutsitsbiixiya gagadusii - sigooxga nadugisstsiiya

tisdaabiya ni~tu*gunibinaan?


Amistuk essxgatsip NSBHs, agAniip nyuxgaya nadugisstsiis tu*gunibinaan sigoxgAAsts gii bugutsitsbiixiya gagaadusiix. itsii daanists iudesstsiis sigoxgAAsts gii bugutsitsbiixiya gagaadusiix mid~ani gadaubuya “igexsguguyaradugisiisiits”. amustsk ma~nu?gwixiniisip, agitsitsudabuusiyaa amustsk ixsutsix essxgatsisbiixiya mustsg iquexsuguyaradugisstsiis, agi-tsxu-xiniip Abugaa, Adabyu?sin, gii AAniiisii nixii gagaadusiix, gyamiisstsiidudugisstsiis miunyisitsitiisi i tu*duunamutsiisa.

Oo?gutsisaduup Abduuxbiisii-o?bigimskAAsts

iyinapsgagiisit

Amistuk abessatsiip Abduuxbiisii-o?bigimsmkAAsts iyinapsgagiisitsiis anists agooxtisimaanitsi i tu*snAnP amustsk oo?gutsisaduunyaa i do?gwigii “agamisstsiis i dodagiya”. i tu*dayu?giitxinin-mya, iixitsaabi,

Figure 1: The masses of neutron stars and black holes measured through gravitational waves and electromagnetic observations. The yellow and purple markers represent the electromagnetic measurements of neutron stars and black holes, respectively, while the orange and blue markers are the corresponding measurements using gravitational waves. Our signals, J200105 and J200115, are highlighted as the merger of neutron stars with black holes. (Image credit: LIGO-Virgo & Frank Elavsky, Aaron Geller, Northwestern University)

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gwcenter.icrr.u-tokyo.ac.jp/en/
Astamatsaaxin mustsk uutsu?guunimanuwa

Abuduxbiisi o?bigismkAAsts i_dodagayup sugabi Iyinapsguusin tsima i_.~tu*duutsisya, aganyup, manistsiqgii amustsk sigooxga gii bugutsitsbixii dagaadus. amustsk sigooxga gii bugutsitsbixii dagaadus nabAstutisima GW200105 aganyup (nanisi idabaanyup bi_xui) 8.9 idumanisdxduup gii (niduxige idabaanyup bi_xui) 1.9 idumanisdxduup

Figure 2: Summary of our knowledge of the component masses of the objects that produced GW200105 and GW200115. The horizontal axis represents the mass of the heavier object (the black hole), whereas the vertical axis represents the mass of the lighter object (the neutron star). The color-shading indicates mass-combinations consistent with the data, orange for the first event, and blue for the second event. Darker shading indicates better agreement, i.e. a higher probability for such mass-combinations. The top panel summarizes the information about the black hole mass, with -for instance- the blue curve showing that the black hole in GW200115 had a mass somewhere between ~3.5M⊙ and ~7.5M⊙. The right panel summarizes the information about the neutron star mass—for instance, the orange curve in this panel indicates that GW200105’s neutron star had a mass between 1.75M⊙ and 2.2M⊙. The green shadings in this right panel summarize the present astronomical knowledge about how massive neutron stars can be, showing that our observed objects have masses small enough to be neutron stars. The figure also shows information about two earlier gravitational wave discoveries: GW190814, which is probably the merger of a 23M⊙ black hole with a 2.5M⊙ black hole (the lightest ever observed); and GW190426_152155, a signal that looks like a neutron star-black hole system, but is so weak that it is unclear whether it is of astrophysical origin.
ni-tu*gwissxinibina anmi sigooxga oda-ku*bisii mu?k GW200105 itsitsiwi matsitsiwi gii idutstsiwi niitibbu matsidabiduatstsiwi giihibu amustk manistuu oda-ku*bisinists nistsk sigooxgAsts, madaanistiwi mu?k GW200115, udo-ku*bisii itsitsiwi matsitsiwi gii naniisibuu matsidabiduatstsiwi giihibu amustk manistuu. nimatsutsinibinaan amui bugutsitsbixiixi gagadusi udo-ku*bisii i_{-tu}^*dabiwi nanisidxsxiibinaan mado?gunnitsiisana (satsi sinaxin nuu*x).

maganisAxAimsda?binaan nitsinibinaanysa NSBh? agi?lotsi–pu*duup agi?sinini Abaduxbiissi O’bigimskAAs, amustk Iyinibisitsi arsinos’ganstsi gii novuststsiya oyo’gitsiya ma–tu*gagadusiix, axda–mu’awanu tu’?biiya Adamanibutstsissa. utspiqguyisinuwa insuyiits Iyinibisits amustk nadugisstsitsi xsxiibina (naniu idabaaruy bi_xul) 8.9 M☉ gii (nisiidai idabaaruy pi gitsii) 5.7 M☉, a-ku*danyup anisidabiya sigooxgAAs, amustii sa’ku*tsI Iyinibisits issxgxiibya (niduxge idabaaruy bi_xul) 1.9 M☉ gii (niduxge idabaaruy nisidai) 1.5 M☉, mattsxuguwatii _igixi?_gidabyaibii amustk nesxiniip sigooxga.

maniststspaguyisins agessxinip mustsk bugutsitsbixiixi gagadusi, 
ganiststiatsiyo amuu uunigyabi i, dawaw?gop, gyl amustsk Aabuduxbiissi O’bigimskAAs (agessxinip, GW170817).

spiguyisinimts amustk sigooxgAAs niiduyaanistsiya mustsk _igayissxinibiis maniststnini maniststnimiwuwa miixisxgagadusi idAstuwasi gii Asabu*ku*biyop.

tsaisiibugaya, gii
tsaniDAgyabiwa?

gii, tsa amustsk NSBH itsii_daan i_{-tu}^*danastsiya? agaynung itsitsiwi

nadugaya madaanistiwi. amui

i_{-tu}^*danastsiw amuxl nadugam 
gagadusiix ogdugsanisi gii

manis_{-tu}^*spiguyisa oma?gidabiisa, 
gyamim tidesduanatsAxaya, amuyu gagadusi aganisdaibi sigooxga gii gyan matstsi gii gagadusi anu’?k anisadsiwi

bugutsitsbixiixi gagadusi. ni_d{4}ni _gadubaay “nAstsii nadugisstsi Asabu*ku*biyop,” anii nu’gitsi madaaariiwa aganyu

musii bugutsitsbixiixi gagadusiixi gii sigooxgAAs i_{-tu}^*duutsiwa yagitsstsiis amustsk idexdutsAxAyaxin, gii

it_{-tu}^*gunutsi Apstissixamuu. aganisstsi–gadup amu’?k ‘iwinAdabaisa aku*bugasuguma” gii _ido_?gabiiya Aatstsiis 

ixbigiya _gagadusi o?gonaodu1ba, udamanuy tsa amustsk madaaaniisitii, axtstam satsiis manisde–ga-muu’?bissi niiti 

sigooxgAAs, meltst nAstsii nadugisstsi Asabu’?ku*biyop, manisA_d–pu*buins ayoda–ku*bisi nistsk Bhs idumantisistiya

amustk nadugisstsi oda–ku*bisii, aganyu, ni_dAismsdop msgutk bugutsitsbixiixi gagadusiixi utu oda–ku*biisii

igudamanisi anii sigooxga. nuu’gitsi, amu’?k ‘iwinAdabaisa aku*bugasuguma xmsdaan ma_{-tu}^*dAgi

manis_{-tu}^*d–daku*bu_p, gya–mu’?k bugutsitsbixiixi gagadusiixi udo_–ku*bisii matu_?dAgi amui sigooxg xigudamanisi.

o’?gagotsi ami muu sigooxga udo_–ku?*bisii nitsin_{-i}^*_gadupa GW200105 mado?gutsxiinibinaan tsa g i_dabistutsiipya 
a’?gamaniststi. _udayexsgga?buwa, mu’?k GW200105, nitsinibinaan amui sigooxga oda_–ku?*bisii udu–mu?duutsi

nuu’?gidanintsi ami muu nadugisstsi oda_–ku?*bi. esasagintsi, amu’?k bugutsitsbixiixi gagadusiixi agidodaku*badumu amui 
siogooxga aganisstnian _i_dex–tsgium, awagyiya?gyudwa xani sigooxga agodaku*bi aganisstnii _gada undamansiti, 
gaganyup _i_dex–tsugium essga?gyudwa. ganyuuyu _i_dApstiisgaiduwa uutsu?gyunimanuwa mu’?k GW200115

i_{-tu}^*duutsi viixi _ido_?ganop*, aganyup buwgu o’?gonaodu1ba.

tsanitsua amustk NSBh? amui spu’ts Abaautstsiya manisA_damsiiya? mu’?k essxgsaip amustk nadugaya NSBH 
itsii_daan awani–giiyaa itsii tidugotsse nisdiu niisitiisgububuidu amustk itsii_daan idAbutsiya niduxge issduyisi xiuxtunatsiisitiw anatsi manisA_daduwa, madaanistiwi, amuu’tsiiuxstuupin manisA_Abuutsiya issuyabaabanistusii 

mu’?k nAstsii nadugisstsi Asabu’?ku*biyop gyl ‘iwinAdabaisa aku*bugasuguma amui asidabi gagadusiixi o’?gonadubya 

itsidobi, nimaA_ganyup amuuyly a’?gamanisstsiu idudabiwi.

Figure 3: The inferred spin magnitude and direction of the black holes (left half-disks) and neutron stars (right half-disks) of GW200105 and GW200115. The radius of the disk indicates the spin magnitude, and range between 0 (no spin) to 1 (maximum rotation rate of black holes). The spin direction is shown as an angle, which ranges from 0° (objects spin in the same direction as the orbit of the binary) to 180° (objects spin in the opposite direction of the orbit of the binary). Shading indicates probable values of spin magnitude and direction. The leftmost hemisphere has shading that peaks near the horizon, indicating that GW200105’s black hole has a spin that is likely small. The second to right hemisphere’s shading extends downward, indicating that GW200115’s black hole may be spinning in a direction opposite to the orbital motion.
FIND OUT MORE:
Read a free preprint of the full scientific article here.

GLOSSARY

**Insipiral**: The orbital motion of objects in a binary system such as a neutron star-black hole binary. As the binary loses energy by emitting gravitational waves, the neutron star and black hole orbit faster and faster, and approach ever closer until finally merging.

**Neutron star**: The relic of a massive star that has reached the end of its life. When a massive star has exhausted its nuclear fuel, it dies in a catastrophic way—a supernova—that often results in the formation of a neutron star: an object so massive and dense that atoms cannot sustain their structure as we normally perceive them on Earth. These stars are about as massive as our sun, but are only a few tens of kilometers in diameter.

**Black hole**: A region of space-time with gravity so intense that it prevents anything, including light, from escaping. **Black holes** come in different sizes: **stellar-mass black holes** originate from stellar collapses and their masses range from a few solar masses to about 65 solar masses. **Intermediate-mass black holes** range in mass from around 100 solar masses to $10^5$ solar masses. Finally, **supernova** black holes range from more than $10^5$ solar masses to more than $10^7$ solar masses.

**Compact binary**: A system made of two compact stellar remnants, e.g. neutron stars or black holes, orbiting around each other very closely.

**Matched filtering**: A technique to detect signals buried within noisy data. Templates of gravitational waveforms calculated from general relativity are scanned across the data, and ring off when matching patterns are found in the data.

**General Relativity**: The theory of gravity proposed by Albert Einstein in 1915. In this theory, space and time are like a malleable fabric that warps in the presence of matter and energy, and objects follow trajectories through this curved space.

** Globular cluster**: A very dense group of stars bound together by gravity.

**Electromagnetic spectrum**: Visible light stretches from red to violet, but outside the range our eyes can see, this spectrum continues. Beyond red light there is infra-red, microwaves and radio waves, and beyond violet there is ultraviolet, X rays and gamma rays. This is the spectrum of electromagnetic radiation, and astronomers use each part of the spectrum to learn more about the Universe. All electromagnetic radiation takes the form of ripples in electric and magnetic fields, and differ in their frequency or wavelength (the length of a ripple).

**Light year**: A unit of distance equivalent to the distance that light travels in one year. A light year is approximately equal to 9.46 trillion kilometers (or roughly 5.88 trillion miles).

**Me (solar mass)**: The mass of the Sun (around $2x10^{30}$ kilograms). Solar mass is a common unit for representing masses in astronomy.
Blackfoot Translation By: Sharon Yellowfly (Siksika Nation)

This Blackfoot translation of a LIGO-Virgo Science Summary was made by Sharon Yellowfly (daughter of Percy Yellowfly & Cecile Yellowfly [Sleigh] & mother of LSC member, Corey Gray). Sharon grew up in the Little Washington community of the Siksika Nation in Alberta, Canada. Blackfoot was her first language. She began working on making a Blackfoot Dictionary in the 1970s when she noticed the pool of fluent Blackfoot speakers declining and not many language resources available. Her dictionary (& the Blackfoot Pronunciation Guide below) come from her language work during her life. Her translations for the LIGO-Virgo Scientific Collaboration inspired her to continue work on her Blackfoot dictionary and update it with scientific terms.

She made her dictionary for her children.

In recent decades there has been a revitalization with Indigenous language work, and there is now Blackfoot language curriculum available and used within and outside of the Blackfoot Confederacy of Alberta/Montana. You will notice variations in this current curriculum and Sharon’s dictionary. Sharon made her dictionary utilizing her B.A. in Anthropology & background in linguistics. Sharon’s dialect & translation come from both “old style” & contemporary Blackfoot; additionally, it will be how it is spoken in a dialect/accent from the Little Washington community in Siksika Nation. Sharon is very happy to see the resurgence in Blackfoot language and is very proud of all the teachers teaching our language to Blackfoot youth.

### Blackfoot Pronunciation Key For Vowels, & Other Symbols:

<table>
<thead>
<tr>
<th>BLACKFOOT</th>
<th>ENGLISH</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>father</td>
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<tr>
<td>i</td>
<td>eat</td>
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<tr>
<td>u</td>
<td>book</td>
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<tr>
<td>o</td>
<td>go</td>
</tr>
</tbody>
</table>

- **x - six**
- **A - acorn**
- **I - ice**

- ? - glottal stop
- _ - as in ‘he’ but held a little longer
- * - who
- ~ - (not quite a full glottal stop ) as in ‘cotton’

[bold & italics] - inflection