*ma*nuutsu?guu*nim*yawa miistsk Abuduuxbiisii o?bigimskAAsts: bugutsitsbiixiya gagadusii - sigooxga nadugisstsiiya

tsis*da*biya *ni~tu**guniibinaan ?

ni_k manstuyadusi nisidui nixii Advanced LIGO detector miim Livingston, Louisiana anuum US gii nixii Advanced Virgo detector miim Italy ***nessx***gatsimya Abuduuxbiisii o?bigimskAAsts i***duu***manists***tsi***ya nuu?***gi***tsiists axiibiisabesspsabii i***tsii***_daan. amustsk Abuduuxbiisii o?bigimskAAsts i_dubitsiiya ***A***nii~wa? ***A***nixsesstsii nadugaya i***gu***motsitsga***nis***tsii Iyinibiists ***mii***sta~pu*bu?ts: ***niyIy***, bugutsitsbiixiya, ***gyanI*** sigooxga. LIGO gii Virgo ***nessx***gatsimya sagui ***a***gogaapstsiiw oda~ku*biisiniists (i***tsa***bo***da***xiinagasii), i_tu****tsa***batstsii anII ***nA***buutu?biiya mu?k bugutsitsbiixiya gyamui sigooxga. bi***sa***dabii, gibwi***xis***tsigui mats***tsi***giya Abuduuxbiisii-o?bigimska **I**yiinaps***ga***gii i_tu****duuts***tsii amu?k i***tsa***bo***da***xiinagasii gii ***nA***buutu?bii mu?k bugutsitsbiixiya gagadusii ***gyanI*** sigooxga, ***nessx***gatsimya, anu?k ni***duu***yii Advanced LIGO itu?***gu***tsiisaduu***byu***yix (miim Livingston gii miim Hanford, Washington) gii nixii Virgo itu?***gu***tsiisaduu***byu***yi. amu?k ***maa***nanistsiiw Abuduuxbiisii o?bigimskAAsts ***nessx***gatsibya ***awa***sugabiya mustsk bugutsitsbiixiya gagadusiix gii sigooxgAAsta (satsit sinaxin ni***dux***ge). bitsiistuui ***mans***xinimya, Abuduuxbiisii o?bigimskAAsts ***essx***gatsiibya A***buutu?***biisii nadugayiists sigooxgAAsts, gii nadugayiists bugutsitsbiixiya gagadusii. amustsk ***ma***~nu?gwisxiniibinaan ***a***gibitsi~ni_gadaya ***agi***bitsini_***ga***daya **GW200105** gii **GW200115**.

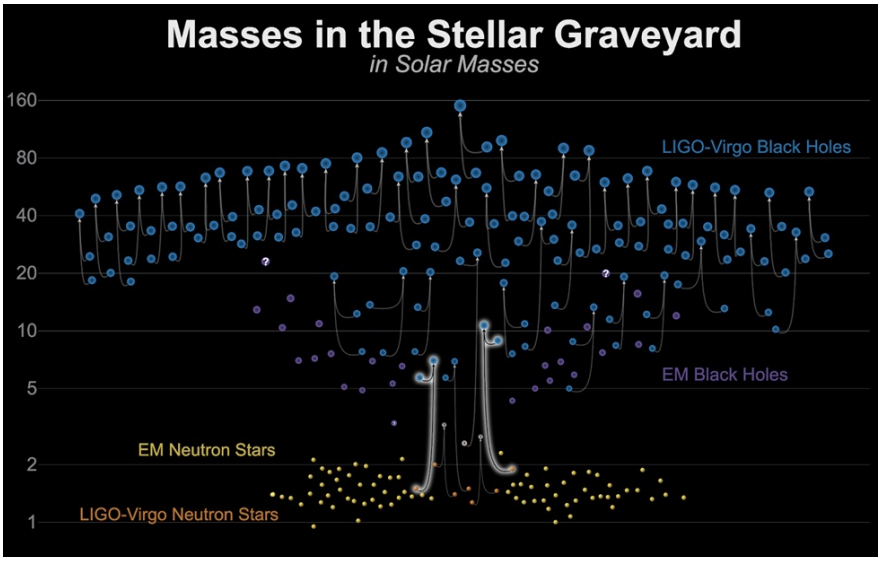

***Figure 1**: The masses of neutron stars and black holes measured through gravitational waves and electromagnetic observations. The yellow and purple markers represent the electromagnetic measurements of neutron stars and black holes, respectively, while the orange and blue markers are the corresponding measurements using gravitational waves. Our signals, **GW200105** and **GW200115**, are highlighted as the merger of neutron stars with black holes. (Image credit: LIGO-Virgo & Frank Elavsky, Aaron Geller, Northwestern University)*

amustsk nadugaya ***ma***~nu?gwisxiniip ***Astama***tsugii ma***duums***tsi oo?gutsiisaduumyatsiix amustsk neutron star-black hole (NSBH) i***tsii***_daanists. i***gii***naxisamuu, NSBH i***tsii***_daanists ***ii***gayissxinibiists ***a?***gitstsiya, ***ii***noxsawo?guunimya, i***no***ganistsiiw anu?k.

amu?k ***essx***gatsiip NSBHs, ***a***gAniip ***nyux***gaya nadugisstsiists i_tu****da***nistsiiya sigooxgAAsts gii bugutsitsbiixiya gagadusiix. i***tsii***_daaniists ii***dess***tsists sigooxgAAsts gii bugutsitsbiixiya gagadusiix ni***dAni***_gaduubya "i***gess***suguya nadugisstsiix". amustsk ***ma~nu?***gwisxiniip, ***a***gitsibuts***duu***bya amustsk ***iss***sutsik ***essx***gatsibiists mustsk i***gess***suguya nadugisstsii, ***a***gi-tsux-xiniip ***A***bugaa, ***A***dabyu?sin, gii AA***nii***sii nixii gagadusiix, ***gyan***nistsii iduutstsiists mya***nis***tsitstsiiw i_~tu*du***mats***tsiya.

oo?gutsiisaduup Abuduuxbiisii-o?bigimskAAsts ***I***yiinaps***ga***giists

amustsk ***a***bessatsiip Abuduuxbiisii-o?bigimmskAAsts ***I***yiinaps***ga***giists ***a***nists agooxtsiimaaniists i_~tu****sin***Ap amustsk oo?gutsiisaduumya i_***do?***gwigii "***a***ganistsiists i_***do***dagiya". i_~tu****dayu?***giitsxinim-mya, i***xis***tsaabi,

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agooxtsiimaaniists ***ii***gayissxiniip amustsk ***I***yiinaps***ga***gii i_~tu***duuts***tsiiw Einstein's bi***saa***tsinsimaan. ***a***ganistsiits i_***do***dagiya si***guuts***tsimya Abuduuxbiisii- o?bigimskAAsts ***I***yiinaps***ga***gii, ***a***ganyup i***ga***niststsiiw amux A~ni_giix ***ess***xinimya tsiya amuu i_***deni***_gyup, gyI i_***des***dugimop, gyI i_***de***~gyup. ni***dA***ximsta?binaan amu?k GW200115 anis***da***biiw axiibiisabesspsabiisin Abuduuxbiisii o?bigimskAAsts ***I***yiinaps***ga***gii ***nu?***ganis***dA***suximsda?binaan, ***a?***ga~mu?danis***dA***siiya ba?***sa***bii isstsaabiists ni***dux***gAAsts issduyis a***yess***satsiik gibuma?xdudaxin**.** gymu?k axiisabesspsabiisin amui GW200105 i***gu***tsits~ku*xims-staansinyup ***a***gidabisduutsiip Asabaduumuguiists, gii ***A***dAAbuyii a***yess***satsiminaan amustsk isstsaabiists i_~tu****dots***tsiya ni***dA***nibinaan, gii ni***dA***ximsta?binnan amustsk ***I***yiinaps***ga***gii ***a***gidamanistsiiw ***a***gidudabiiw isstsaabiists ***a***ganyup na***duux***gAAs gii ganayuxgessduyis.

NSBH ii***buts***tsiisiix ***a***gu~tu*, i***do***mAdagyup, i_duda***nis***tsii a***na***tsii abamuu?ts ba***bu***suxbiisiists ***A***sabaduumya. i***no***ganistsiiw, uu***dumu?***duutstsii spu?ts mustsk uutsu?guunimanuwa ma***dA***suku*issxgwiip, ***a***gides-satsiip spu?ts ***no***tsitsgu~***ma?***~ximya nah gugu***mi***giis i***duu***minudu?sii Asa***banis***tsisii. e***buuts***dugyup manis***tsi***byuu mu?k uutsu?guunimanuwa (aku*tsuxibuyup xi***yuu?ts***), amu?k ***essx***gatsiip ba***bu***suxbiisiists ana~tsi ma~tu?banyup, gii ***ma***tsiniibya. ***iss***sutsik ***essx***ga***miists***tsiists amustsk NSBH ii***buts***tsiigiix ***a?ga~mu?du***danistsiiw ***a***gAniip ana~tsi agi~tu*tsxiniip amustsk sigooxga "***e***~gamiguyi ***awa***sugabiistutsiip" (nawanuuxisdutsiip) mu?k bugutsitsbiixii gagadusii. ***amu?***gI ***a?***ga~mu?gugiya Iyiinapsgugi amustsk igumotsitsganistsii a***go***madabanstsiists its***pa***biists ***a***ganisdAsii bugutsitsbiixi gagadusiix.

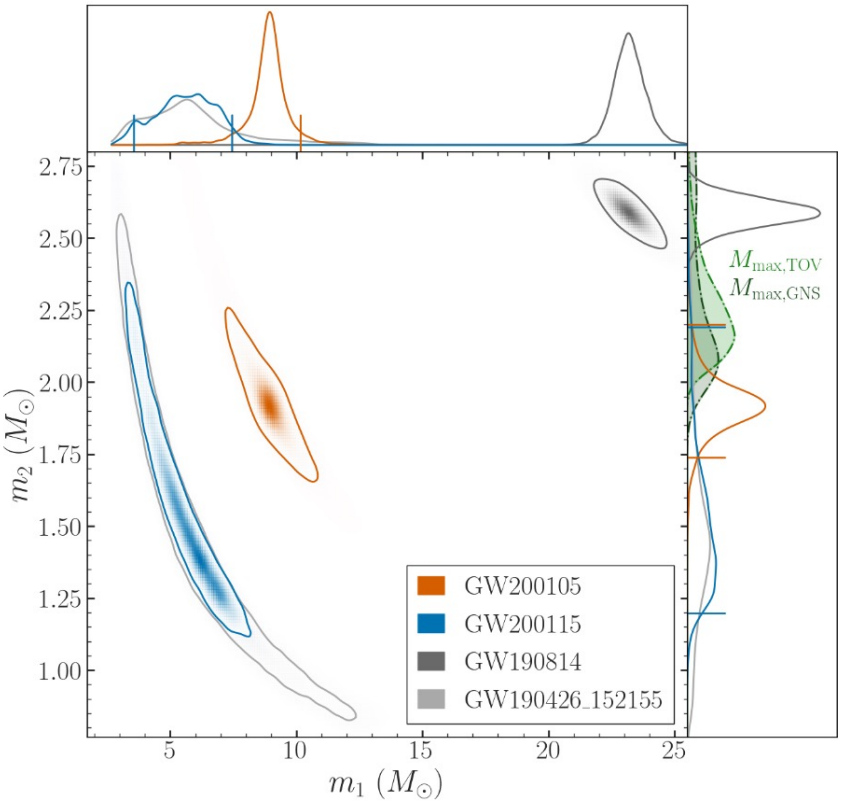

Figure 2*: Summary of our knowledge of the component masses of the objects that produced GW200105 and GW200115. The horizontal axis represents the mass of the heavier object (the black hole), whereas the vertical axis represents the mass of the lighter object (the neutron star). The color-shading indicates 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.*

Astamatsaaxin mustsk uutsu?guunimanuwaa

Abuduuxbiisii o?bigimskAAsts i_dodugagyup sugabi Iyiinapsguusin tsima i_~tu****duuts***tsiya, aganyup, ma***nists***spiguyi amustsk sigooxga gii bugutsitsbiixii gagadusii. amustsk sigooxga gii bugutsitsbiixii gagadusii nabAstutsimya GW200105 aganyup ***(na***nisui ida***baa***yuup bi_***xui***) 8.9 idu***manis***duxduup gii (ni***dux***ge ida***baa***yuup bi_***xui)*** 1.9 idu***manis***duxduup

notsitsku*spi***gu**yisaduum nah nadusii (ni***dAsi***nAp ***spi***guyis M⊙), ***a***go?dAbuyup. amu?k GW200105 o?ganabi ***a***gAsamanisdAsiiw, i***duma?***guxdaxin issduyiists ***madu***mAdabiiya mixisk ***uuma?***xamsgiix anuum xa?gui. gyanii GW200115 o?ganabi, nitsuuxstuubinaan amui sigooxga gii bugutsitsbiixii gagadusii uts***spi***guisinuwa issxgwiibya (nisidui ida***baa***yuup i_gi***tsi***gIi) 5.7 M⊙ gii (ni***dux***ge ida***baa***yuup nisidui) 1.5 M⊙ aganyup, gyamu?k utsi***buts***daanya ***a?***gi~tu*gabiiw gibuma?xdudaxin issduyiists. spi***gu***yisiists su***gabu***yabanigyannya si***na***xin ***na***duge.

ni~tu*gwissxi***ni**binaan ***an**ni sigooxga oda~ku*bisin mu?k GW200105 itstsiiw ***ma**tsitstsiip gii i***dut**stsiiw niii**i**buu ***ma**tsidabi***duut**stsiiw gii***bi**bu amustsk manistsuu oda~ku*bisiniists nistsk sigooxgAAsts, ***ma**danistsiiw mu?k GW200115, u***do**da~ku*bisin itstsiiw ***ma**tsitstsiip gii ***na**niisibuu ***ma**tsidabi***duut**stsiiw gg***bi**buu amustsk manistsuu. ni***matsut**sxinibinaan amui bugutsitsbiixii gagadusii u***do**da~ku*bisin i_~tu****da**biiw nanis***desx**gwiibinaan ***ma**do?guu***nii**sanaan (satsit sinaxin ***nuux**ge).

ma**ganisdA**ximsda?binaan nitsi***ni**binaanya NSBHs? ***agi**dotsi~pu*duup ***agi**tsiniip Abuduuxbiisii O?bigimskAAsts, amustsk Iyinibiists ***ax**tsino?ganstsiya gii ***no**butstsiiya ***a**yo?gitsiya ma~tu*gagadusiix, axda~mu?awanu?tu?biiya Ada***ma**gi***buts**tsiisa. uts***spi**guyisinuwa isu***gu**yiists Iyinibiists amustsk nadugisstsiists ***nesx**gwiibya ***(na**nisui ida***baa**yuup bi_***xui**) 8.9 $M_\odot$ gii (nisidui ida***baa**yuup i_gi***tsi**gIi) 5.7 $M_\odot$, ***a~ku****danyup anis***da**biya sigooxgAAsts. amustsii sa?ku*tsi Iyinibiists issx***gwii**bya (ni***dux**ge ida***baa**yuup bi_***xui)*** 1.9 $M_\odot$ gii (ni***dux**ge ida***baa**yuup nisidui) 1.5 $M_\odot$, ***mats**suguwatsix i***gii**xa?gidabyabiiya amustsk ***nes**xiniip sigooxga.

ma***nists**spaguyisin ***a**gessxiniip mustsk bugutsitsbiixii gagadusii, i***ga**nistsi***na**tsiya amuu uunigyabi i_dawaw?gop, gyI amustsk Abuduuxbiisii O?bigimskAAsts (agessxiniip, GW170817). spi***gu**yiisiniists amustsk sigooxgAAsts nii***du**yaanistsiiya mustsk ***ii**gayissxiniibiists manistsinim manis***tsi**nimsuwa miixiskgagadusii i***dA**stuwasii gii ***A**sabu?ku*biyop.

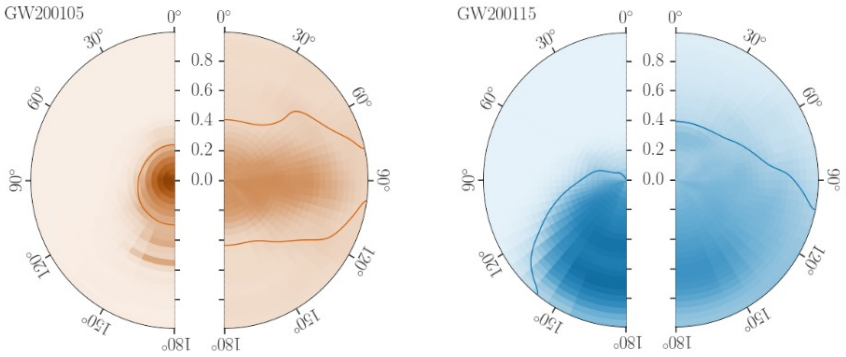

Figure 3: The inferred spin magnitude and direction of the black holes (left half-disks) and neutron stars (right half-disks) of GW200105 and GW200115. The radius of the disk indicates the spin magnitude, and range between 0 (no spin) to 1 (maximum rotation rate of black holes). The spin direction is shown as an angle, which ranges from 0º (objects spin in the same direction as the orbit of the binary) to 180º (objects spin in the opposite direction of the orbit of the binary). Shading indicates probable values of spin magnitude and direction. The left-most hemisphere has shading that peaks near the centre, 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.

tsa**itsii**bu**gaya, gii **tsa**ni**dA**gyabiwa **?

gii, tsa amustsk NSBH i***tsii**_daan i~tu****du**matstsiya? aganyup itstsiiw nadugaya ***ma**banistsiiw. amui i_~tu*da***nis**tsiw ***a**muxI nadugam gagadusiix odguxgasiiya gii ma***nis~tu****spiguyisa oma?***gida**bisa, ***gyan**nimI i***des**duna***tsAx**gaya, amuya gagadusii ***a**ganisdabii sigooxga gii ***gya**ni mats***tsi**gi gagadusii anu?k anis***dap**siiw bugutsitsbiixi gagadusii. ni***dA~ni**_gaduubya "***nAts**tsii nadugisstsii ***A**sabu?ku*biyop". a***nii** nu?***gi**tsi ***ma**banistsiiw aganyup mistsii bugutsitsbiixi gagadusiix gii si***goox**gAAsts i_~tu****duuts**tsiya ***a**yagitstsiisin amustsk i***des**duna***tsAx**gayaxin, gii it~tu****gu**nutsiya Apstsiixisamuu. ***a**ganis***tsin**~gaduup amu?k '***i**bwiinAdabasin ***a**ku*bu***ga**suguma" gii i***do?**gabiya Atstsiis ixbigiiya gagadusiix o?gonudubya. udamanyup tsga amustsk ***ma**banistsiiw, ***ax**stam satsiip manis***de**~ga~mu?bisi ***nis**tsii sigooxgAAsts. mistsk ***nAts**tsii nadugisstsii ***A**sabu?ku*biyop, manis***dA**da~pu*bisin a***yo**da~ku*bisi nistsk Bhs idumanistsiiya amustsk nadugisstsii oda~ku*bisin, aganyup, ni***dA**ximsdop mistsk bugutsitsbiixi gagadusii utu? oda~ku*biisin igidumanistsii anii sigooxga. nuu?***gi**tsi, amu?k ***i**bwiinAdabasin ***a**ku*bu***ga**suguma ximsdaan ***ma~tu****dAgi ma***nis~tu****do~daku*bi_p, gya~mu?k bugutsitsbiixi-gagadusii u***do**da~ku*bisin matu*dAgi amui sigooxga igidumanistsisi.

o?gagotsiigi amuu sigooxga u***do**da~ku?bisin ni***tsin~i**_gaduup GW200105 mado?gutsxiniibinaan tsga i_dabistutsiipya a?gamanistsiiw. u***da**yesxga***tsi**buwa, mu?k GW200115, nitsi***ni**binaan amui sigooxga odaku?bisin u***du~mu?**duutstsi nuu?gidanistsii amui nadugisstsii odaku*bi. ***es**saganistsii, amu?k bugutsitsbixi gagadusii ***a**gidodaku*baduum amui sigooxga ***a**ganistsinam ***i_dex**~tsiguum, ***a**wagyi***ya?**gyuduwa gyanI sigooxga ***a**godaku*bi ***a**ganis***tsini**_gada ***u**damistsiw, aganyup ***i_dex**~tsiguum essga?guduwa. gyamuyIy i_***dAps**tsiiganisduup uutsu?guunimanuwa mu?k GW200115 i_~tu****duuts**tsi ixbigii i***do?**ganop*, aganyup buugwi o?gonudubya.

tsa**nitsu**wa amustsk NSBHs amui spu?ts ***A**buutstsiya mani***stA**samsiiya? mu?k essxgatsiip amustsk nadugaya NSBH i***tsii**_daan ***a**wani~giya itstsii i***tsi**dugesstsi nisidui gii niisii***tsi**gubudui amustsk i***tsii**_daan i***dA**butstsiiya niduxge issduyiis ixstunatsi***bis**tstsiiw anatsi manis***dA**saduup***. ma**danistsiiw, amu?k nitsuuxstuupsin manis***dA**butstsiya is***su**buyaabanisdutsiip mu?k ***nAts**tsii nadugisstsii ***A**sabu?ku*biyop gyI ***i**bwiinAdabasin ***a**ku*bu***ga**suguma amui asi***da**bi gagadusii o?gonudubya itsidobi, ni***mada**ganyup ***amu**yIy a?gamanistsiiw idu***da**biiw.

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GLOSSARY

Inspiral: 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, *supermassive black holes* range from more than 10^5 solar masses to more than 10^9 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).

M⊙ (solar mass): The mass of the Sun (around 2×10^{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:

BLACKFOOT	ENGLISH
a	*father*
i	*eat*
u	*book*
e	*let*
o	*go*

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