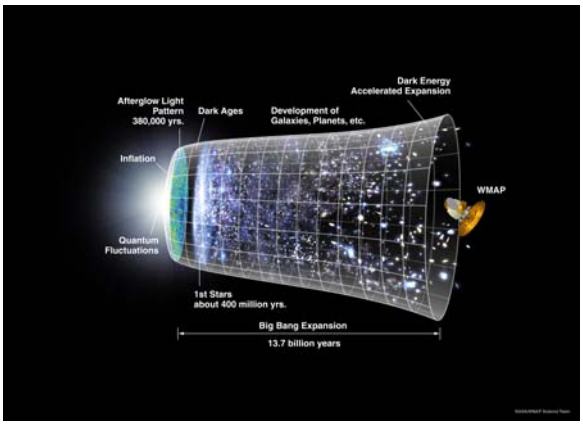
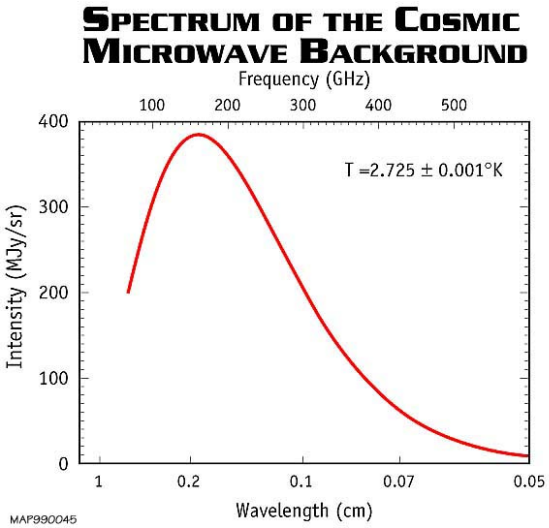
The Universality of Music, and Diversity in Music

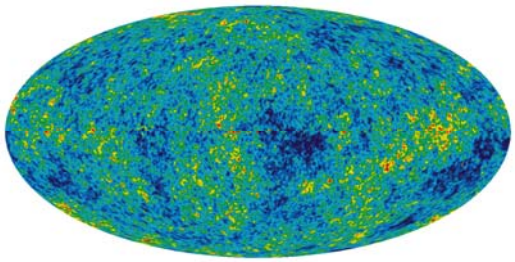
After teaching the Physics of Music/Musical Instruments course(s) here at UIUC for more than a decade, one of the most fascinating, deep questions, or (collection) of things that I like to think about/contemplate is "why music is ***so*** important" to us as human beings – music runs ***very*** deep in ***all*** humans (at least "normal" humans) – so much so, sometimes I seriously wonder if our enjoyment (need?) for music is literally ***genetically*** programmed into (all of) us…

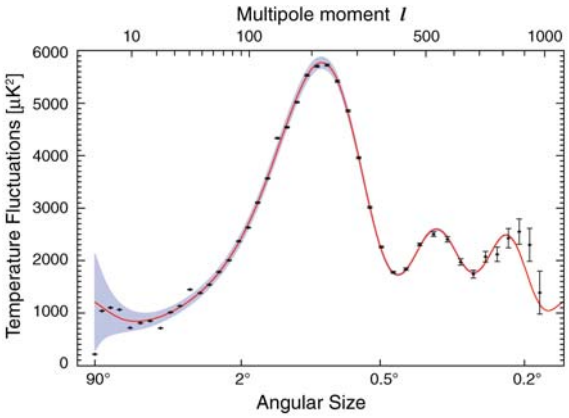
Let's give a brief perspective on the ***timescales*** of what we're about to discuss:

- From various astrophysical measurements – *e.g*. the cosmic microwave background – a remnant of the ***Big Bang***, and measurements of the so-called ***Hubble constant*** – the rate of ***expansion*** of the universe – the age of the universe is ~ 13.7 ***billion*** years old.

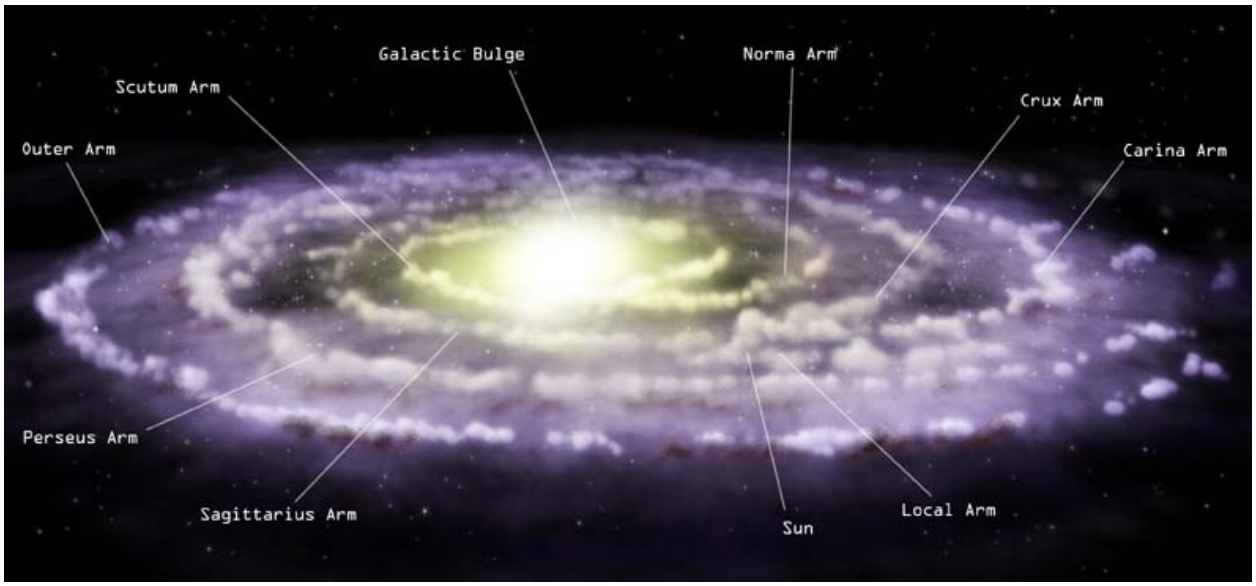




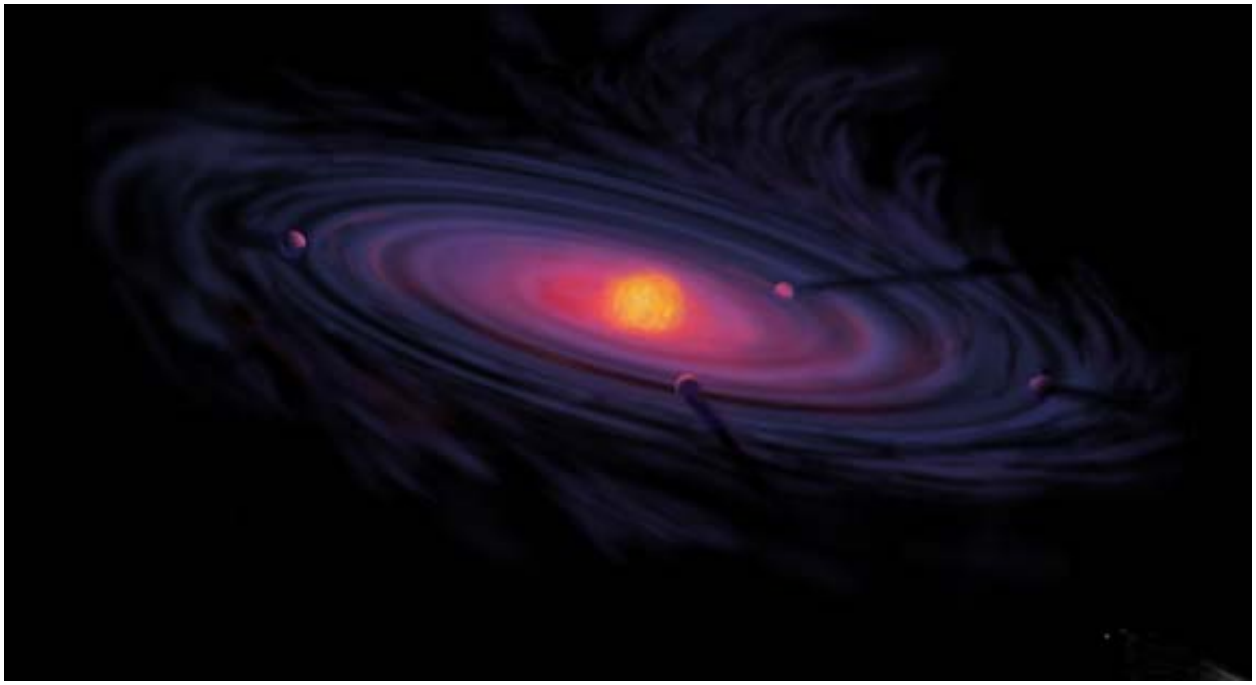




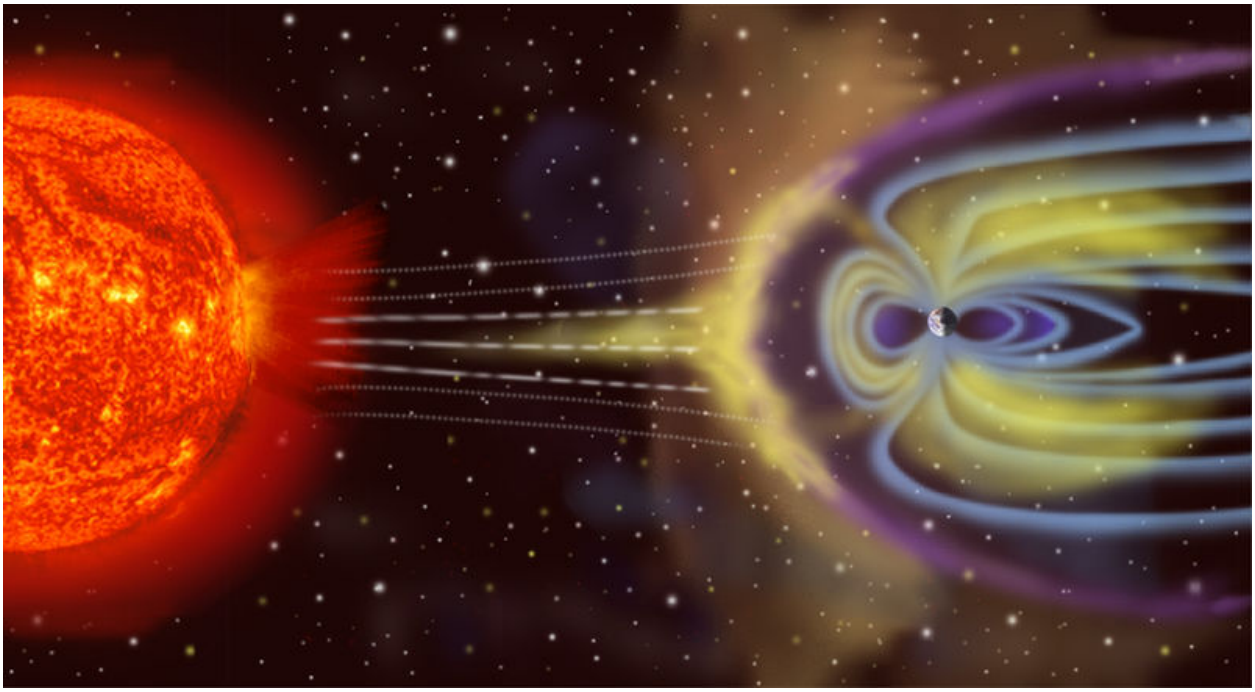
- The age of our own Milky Way galaxy is (at least) ~ 13.2 ***billion*** years old – dated from a single star (HE-1523-0901) in the ***halo*** of the Milky Way galaxy. However the of the Milky Way galaxy is estimated to have formed ~ 8.8 ± 1.7 ***billion*** years ago.



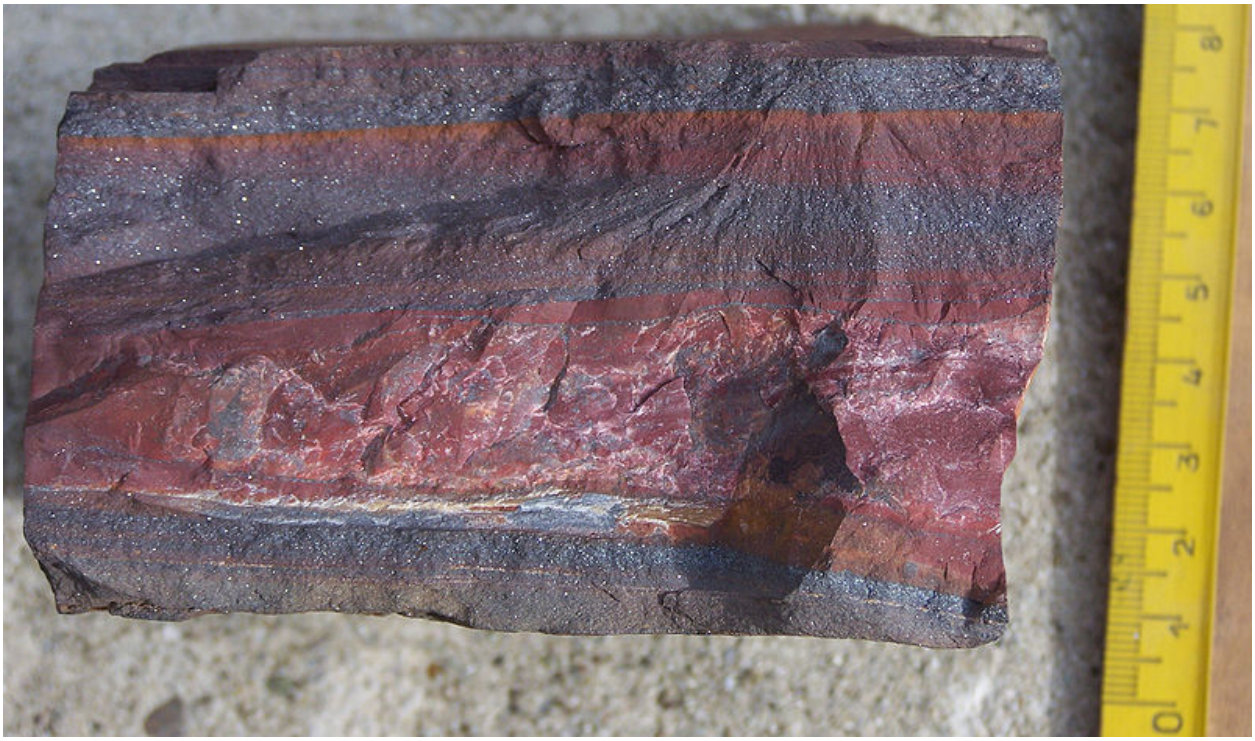
- The age of our own solar system – our sun – is ~ 4.6 ***billion*** years old; the earth formed ~ 60 million years later – *i.e.* the earth is ~ 4.54 ***billion*** years old.



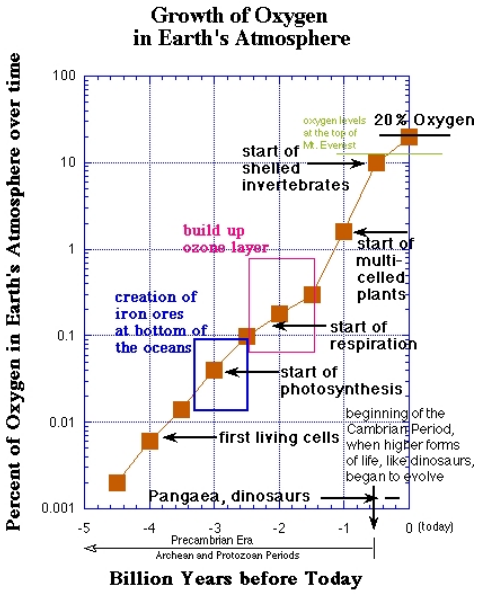
- The earth's magnetic field shields/protects all life from deadly solar radiation:



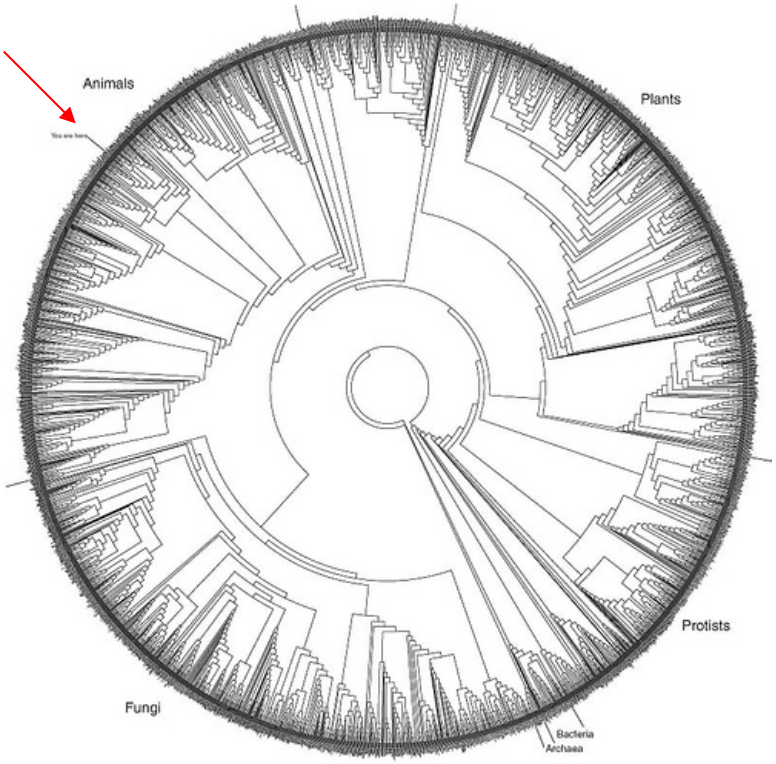
- The simplest (single-cell) life forms appeared on earth ~ 3.8 ***billion*** years ago, photosynthetic organisms ~ 3 ***billion*** years ago. Photosynthesis drove ***oxygenation*** of earth's initially iron-rich oceans – iron oxide precipitated (i.e. rusted) out/deposited on ocean floor – leaving sedimentary banded iron formations:



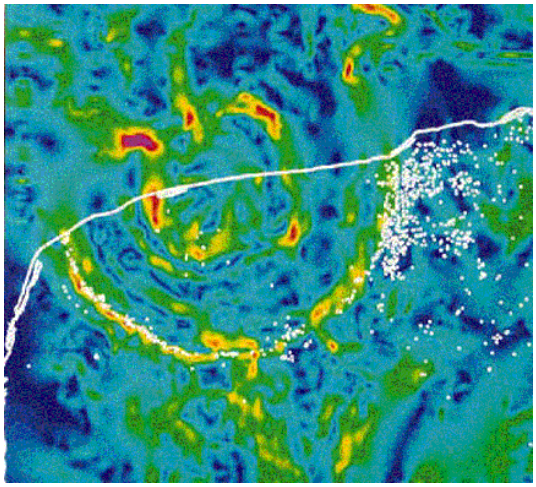
- Subsequent oxygenation of earth's atmosphere – by ***stromatolites***:

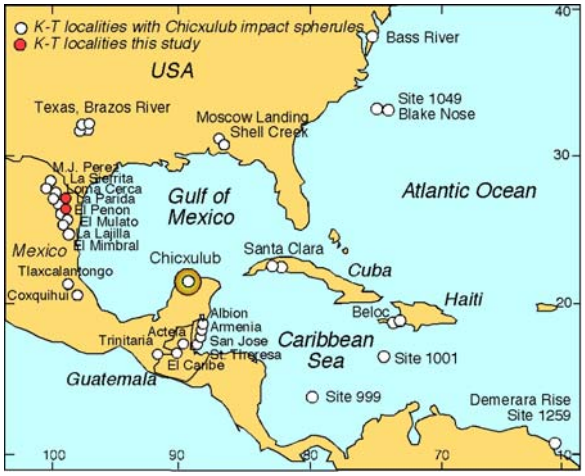


- Complex-celled creatures ~ 2 ***billion*** years ago, multi-celled life forms first appeared ~ 1 ***billion*** years ago.



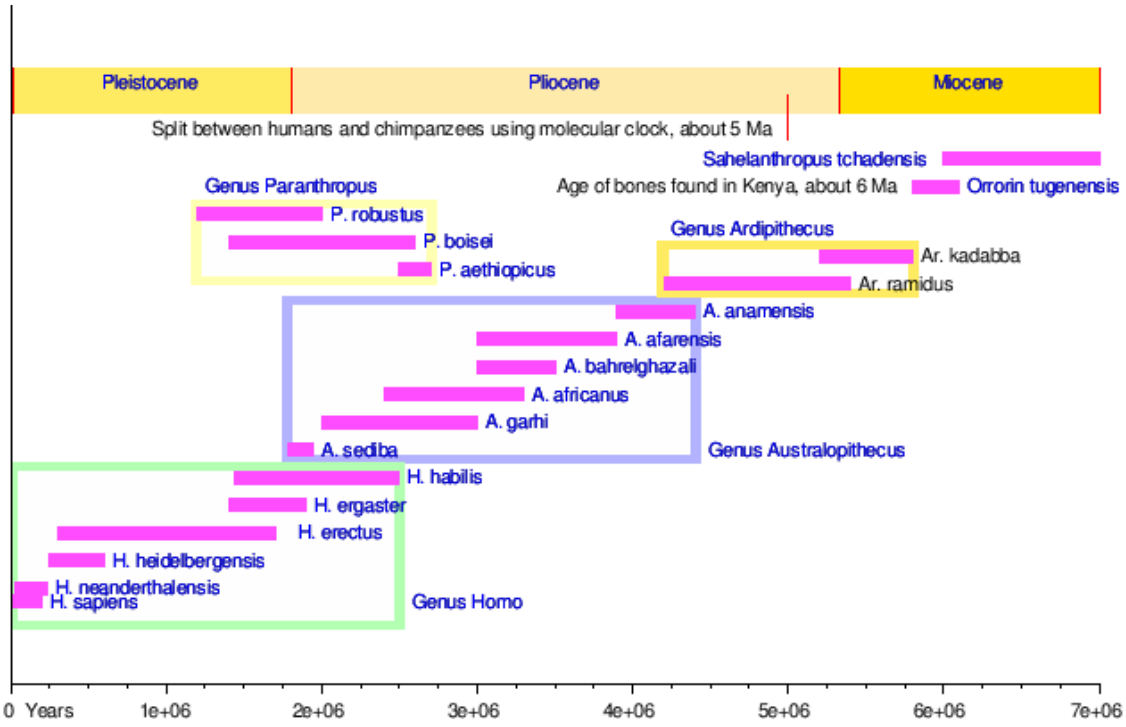
- The dinosaurs died out ~ 65 ***million*** years ago in the aftermath of asteroid ~ 6 miles in diameter impacting the earth – leaving a crater ~ 110 miles in diameter, which today is near the town of Chicxulub, in the Yucatan peninsula.



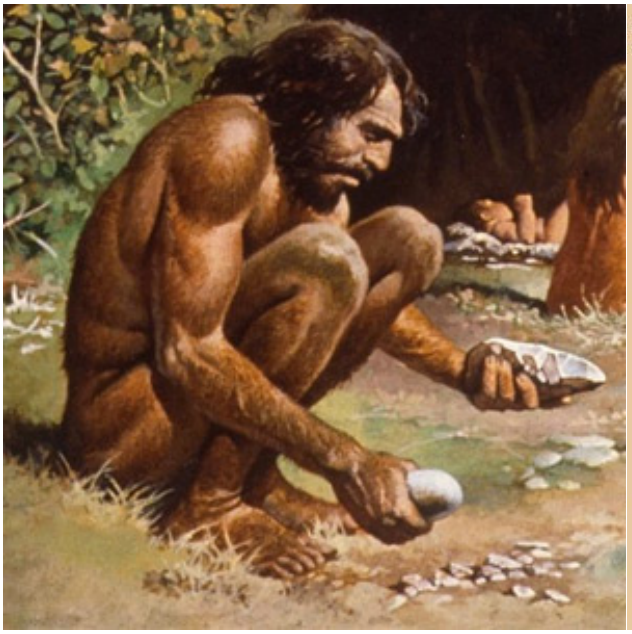


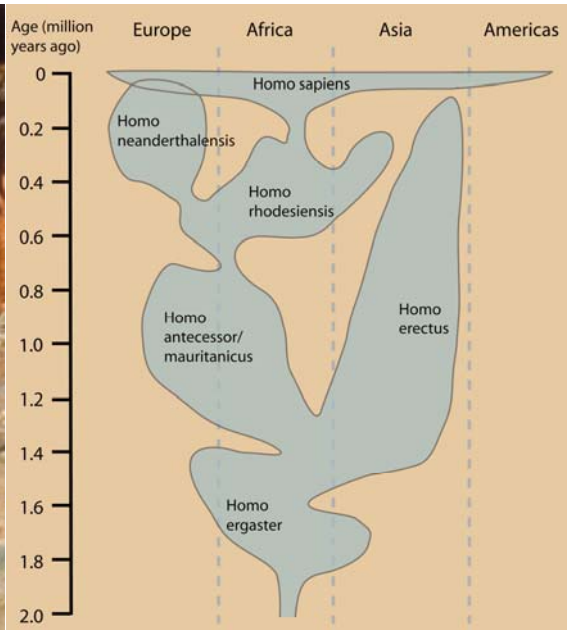
- Our ~ distant ancestors – ***Australopithecus afarensis*** (2.9-3.9 Myr ago) had developed ***bi-pedalism***, but lacked the large brain that modern humans have today (prefrontal cortex).

- Our earliest ancestors (of the genus ***homo***) – ***H. habilis*** first appeared ~ 2.5 million years ago. ***H. Habilus*** used tools – *e.g.* stone flakes – primarily for scavenging. They weren't great hunters.

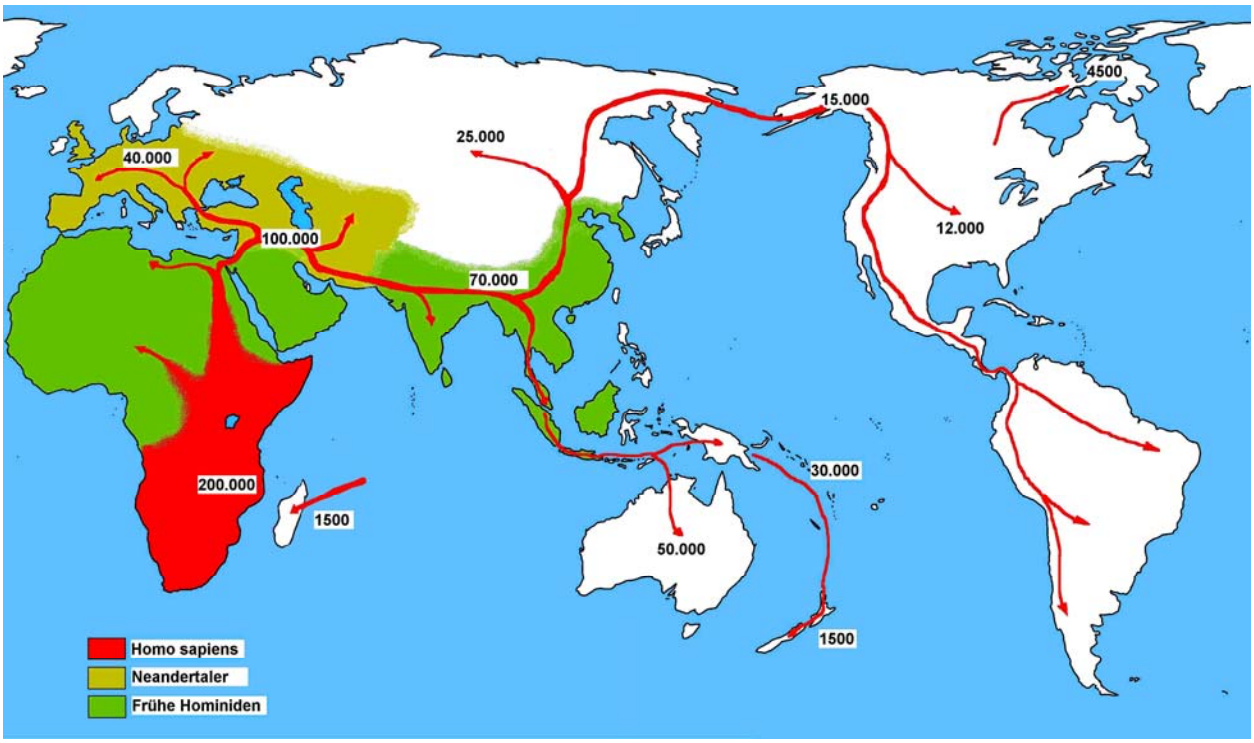


- ~ 200,000 years ago, our ***direct*** ancestors – ***H. sapiens*** first appeared – looking not ***too*** different than ***we*** do, today!





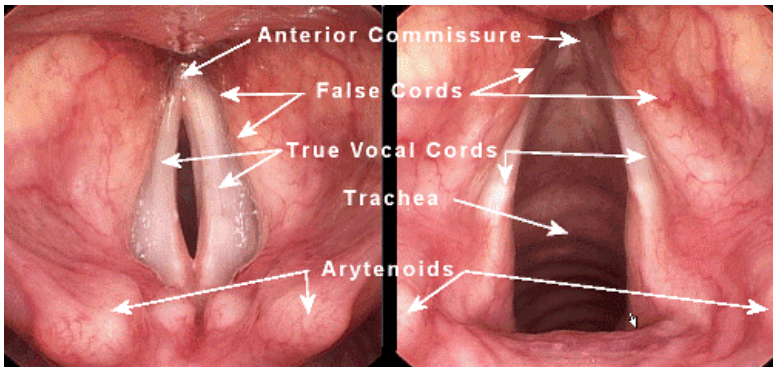
Spreading/migration of homo sapiens with time:

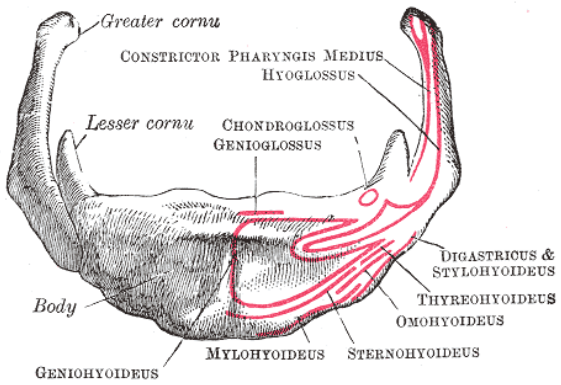


- ~ 25,000 years ago, the Neanderthals (***H. neanderthalensis***) went extinct…

  ⇒ Our own human species – ***H. sapiens*** has only been around for a blink of an eye!

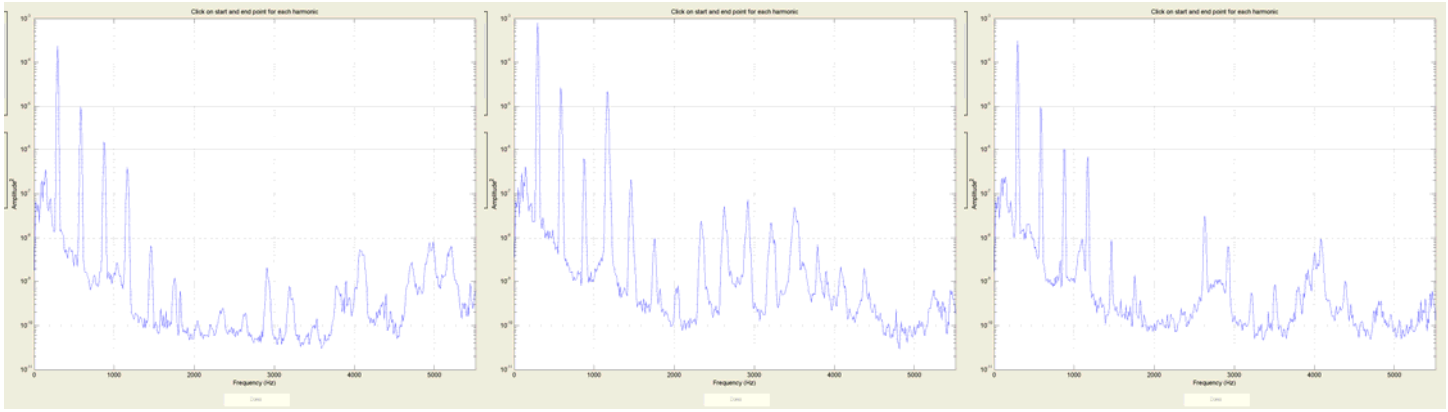
- The human voice – the first musical instrument – our vocal chords + the hyoid bone – present in many mammals, but is ***unique*** to humans – enabling production of a wide range of sounds that other animals ***cannot*** produce – the human hyoid bone allows wider range of tongue, pharyngeal and laryngeal movements – all necessary for human speech and song! How did this happen?



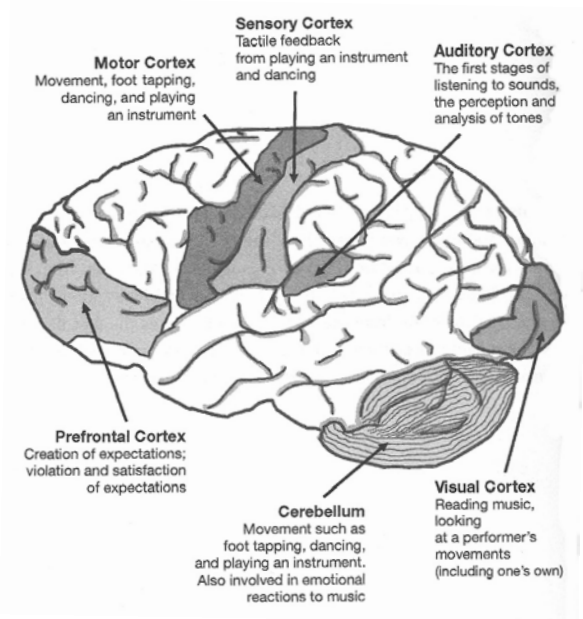


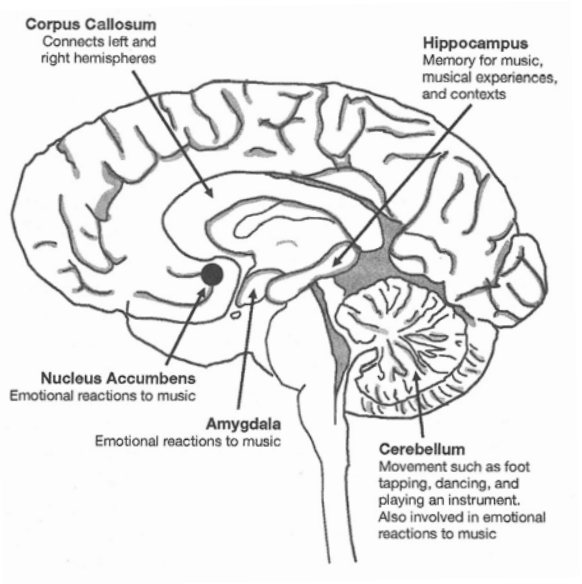
- Human vocal chords vibrate as 1-dimensional system – produces integer-related harmonics when singing a note – i.e. $f_n = nf_1,\ n = 1, 2, 3, ...$ Comparison of harmonic spectra of three female students in P193POM course singing the same note D4 "ooooh" (293.66 Hz):

Abby: Molly: Cheryl:



- As we have mentioned/discussed in previous POM lectures, there is ample evidence of the importance of music to our species – music very definitely can and does evoke ***emotional responses*** – because the sound-processing & music centers in our brains ***are*** wired into various of the emotional centers in our brains. Why is this? How did this happen?





- A series of recent studies of the human brain using functional Magnetic Resonance Imaging (fMRI) and saliva samples have shown that complex "feel-good" brain-chemicals such as ***serotonin***, ***dopamine*** and ***oxytocin*** (the latter is linked to feelings of trust and well-being) are released when listening to and/or participating in music. The release of such "feel-good" brain chemicals ***also*** has been shown to boost our immune systems. Furthermore, pleasurable listening or participating in music results in a ***reduction*** of the chemical ***cortisol***, which is linked to ***stress***, which is also obviously beneficial to us…

- Our ability to recall musical memories – ranging from accurate recall of detailed, complex sounds/tones to whole songs/whole albums – is also ***amazingly*** long-term "robust" – significantly more so than that for "normal/everyday" memories, *e.g*. recalling the names of people you are introduced to at a party, or what you ate for breakfast last Thursday morning, *etc*. Neurological studies of the human brain have shown that musical memories are stored in more than one location in our brains, whereas this is ***not*** so for "normal/everyday" memories, thereby enabling/facilitating the much better recall of musical memories. Why is retention of musical memories so much more apparently important? How did this come to be?

- So why ***is*** music ***so*** important to us that we need to, and do remember music so much better than most everyday things in life? How did it come to be that music can have such a profound emotional impact on us? And so much so that "feel-good" brain chemicals are produced – our own reward system…

- Apparently, at some time in the distant past – to our ancestors – music was (for some reason, or reason***s***) ***extremely*** important, important enough to us as a species at that time, and also for long enough that the importance of music has left its profound mark – essentially a ***genetic imprint*** – on the ***functioning*** of our brains!

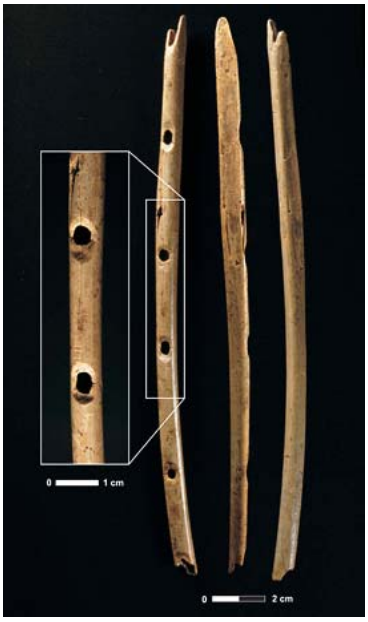
- Clearly, humans ***are*** social animals – and, it was precisely our sociability that enabled us, over the millennia, to collectively transform ourselves – ***homo sapiens*** – living in the stone age natural environment ~ 200,000 years ago – to the artificially-elevated "highly technological" one that we live in today… If music was ***so*** important to us ***then*** as a species, did it also somehow play an important role in helping to get us from our humble beginnings to where we are today? If so, how?

- It is also important to note that amongst ***all*** of the billions of different species of living creatures on this planet, ***no*** other creatures on this planet even come close to us in terms of being curious/driven to comprehend/quantitatively understand the world (not to mention the universe) in which we live, at least to the extent/lengths/efforts our species has gone to. We, as a species are ***unique*** in this regard – we're the ***only*** ones on ***this*** planet that have done so!

- If life exists elsewhere in the universe, what are the chances that any of ***those*** life forms are ***also*** sufficiently curious enough, driven to ultimately master ***their*** own planetary environment? What might ***they*** have learned, that *we* may have ***missed*** on our own journey from the stone age to the present day?

- The earliest known musical instruments, *e.g*. turnduns (*aka* "bullroarers") – airfoils (!!) swung by a rope in a horizontal plane (top right pix), and simple bone flutes – such as the one shown in the bottom right pix (found in 2008 in a cave near Hohle-Fels, located in southwestern Germany) date back to the Pæleolithic era – *i.e*. ~ 30,000 – 40,000 years ago.

- A replica of this 5-hole bone flute was given to a professional musician who was able (after a period of time learning how to play it) to play clear renditions of the "Amazing Grace" and the German national anthem ("Das Deutschlandlied") on this flute – indicating that early humans at that time already ***must*** have had a clear notion of ***consonant intervals and the pentatonic and diatonic musical scales***!



- Archeological evidence from various sites indicates that music ***and*** dance ***were*** an important part of ritual ceremonies in early ***homo sapiens*** culture(s), which helped to reinforce/strengthen social bonds within such groups.

- Presumably ***homo sapiens*** were making music long before ***this*** era in our history – but what were their musical instruments at ***that*** time? The human voice itself had to be ***the*** first musical instrument. Perhaps a bit later, drums and/or other simple "noise-makers" of some kind? Since we are ***anthropocentric*** creatures, it is ***no*** accident that the 1-dimensional musical instruments we have today with their integer-related harmonic overtone sequences ***all mimic*** the human voice – admittedly, some more so than others, and usually in an artistically abstract manner. Percussion instruments obviously emulate human ***rhythms*** – *e.g*. our heartbeats, breathing, blood pumping, etc.

- Was human music an important part of very early human language?

- Or perhaps human music as a language itself ***predated*** what we think of as human language(s) today??

- Note that our ***written*** language began in the relatively very recent past, only ~ 6000 years ago, coinciding with transition(s) of our societies from being hunter-gatherers to agrarian ones.

- Prior to this, did music serve as an important ***oral*** means of preserving/passing on human history, important worldly knowledge, *etc*. to younger generations? Is this (at least, in part) why musical memories are ***so*** strong? Many Native American, South American and African cultures did/still do indeed use music for precisely such purposes, in conjunction with the purely ritual/ceremonial/social aspects of music…

- Fast forward to today – with the diversity of human cultures, ethnic groups – it is often said that "music is a universal language" – understood/appreciated/enjoyed by all humans, of all ages – the very young and very old, and by all cultures. The broad diversity that exists in our music today – the many different genres of traditional and new music – because of the enhanced technological capabilities that we have developed to communicate and interact with each other, can now be appreciated, enjoyed on a ***much*** larger scale than at any time in the past. Hip hop, which originated here in the U.S. not that long ago, is now literally a planetary-wide phenomenon, very popular amongst the young adults in many cultures around the world…

- Even though music is a universal language, what each of us individually interpret/understand /think about/experience while we are actively listening to a specific piece of music may be ***very*** different than what others interpret/understand /think about/experience while actively listening to the exact same piece of music. Music creates images and specific sensations in each of our own minds. But the images and sensations are ***not*** precisely the same (or even close to being the same) for all listeners. Still, music "speaks" to ***all*** of us in a manner that ***is*** difficult for us to communicate effectively to each other precisely what we are instantaneously experiencing, using conventional human ***language***. Why is ***this*** so?

- Increasingly so in recent years, collaborations of small groups of musicians from widely different cultural and/or ethnic backgrounds have been getting together to experiment with creating new kinds of music, new sounds, new rhythms, and new musical rules.

- Because music ***is*** a universal language to all humans living on this planet, music has the intrinsic power to greatly facilitate a planetary-wide celebration of our cultural and ethnic diversity, and improve our understanding of each other's respective cultures, and enhance social-bonding between cultures.

- The growth and evolution of the internet and telecommunications in general have enabled great strides in improving and enhancing intercultural interactions in myriads of ways in the past ~ decade, and doubtless will continue to do so in the future. We have also seen dramatic changes in the music "industry" as a consequence of these technological advances in this same time period… will this result in enhanced musical creativity in the future?

- Along with the musical celebration of our cultural and ethnic diversity in today's technologically-advanced world, this ***should*** go hand-in-hand with the ***remembrance*** and ***understanding*** of how we as a species got here from our humble beginnings – and the important role music apparently played in this process in the many millennia since then!

- As one can see, there are many, many ***extremely*** fascinating questions about our ancient history to ponder, ***and*** to pursue. Doubtless, more ***will be*** learned collectively about these issues in the future – many researchers ***are*** actively seeking answers to these and related questions!

If you are interested in reading/learning more about these interesting/intriguing topics, the following is a suggested list of books:

"This is Your Brain on Music – The Science of Human Obsession", Daniel Levitin, Dutton 2006.

"The World in Six Songs", Daniel Levitin, Dutton 2008.

"The Singing Neanderthals – The Origins of Music, Language, Mind and Body", Steven Mithen, Harvard University Press, 2007.

"The Origins of Music", Nils Lennart Wallin, Björn Merker, Steven Brown, MIT Press, 2001.

"Musicophilia – Tales of Music and the Brain", Oliver Sachs, Alfred A. Knopf, Inc., 2007

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