

#SPACE

How Fast Our Universe Is Expanding

Black hole is usually where information goes to disappear but scientists may have found a trick to use its last moments to tell us about the history of the universe.



In a new study, two astrophysicists lay out a method for how to use pairs of colliding black holes to measure how fast our universe is expanding and thus understand how the universe evolved, what it is made out of and where it's going.

In particular, the scientists think the new technique which they call a 'spectral siren' may be able to tell us about the otherwise elusive 'teenage' years of the universe. There's a major ongoing scientific debate over exactly how fast the universe is expanding, a number called the Hubble constant. The different methods available so far yield slightly different answers and scientists are eager to find alternate ways to measure this rate. Checking the accuracy of this number is especially important because it affects our understanding of fundamental questions like the age, history and makeup of the universe.

The new study offers a way to make this calculation using special detectors that pick up the cosmic echoes of black hole collisions. Occasionally two black holes will slam into each other in an event so powerful that it literally creates a ripple in space-time that travels across the universe. Here on Earth, the US Laser Interferometer Gravitational-Wave Observatory (LIGO) and the Italian observatory Virgo can pick up those ripples which are called gravitational waves.

Over the past few years, LIGO and Virgo have collected the readings from almost 100 pairs of black holes colliding. The signal from each collision contains information about how massive the black holes were. But the signal has been travelling across space and during that time the universe has expanded which changes the properties of the signal. "For example, if you took a black hole and put it earlier in the universe, the signal would change and it would look like a bigger black hole than it really is," explains Daniel Holz, an astrophysicist at the University of Chicago, and one of the two authors of the paper.

The method may provide a unique window into the 'teenage' years of the universe that are hard to study with other methods. If scientists can figure out a way to measure how that sig-

nal changed, they can calculate the expansion rate of the universe. The problem is calibration: How do they know how much it changed from the original?

In their new paper, Holz and first author Jose Maria Ezquiaga suggest that they can use our new found knowledge about the whole population of black holes as a calibration tool. For example, current evidence suggests that most of the detected black holes have between five and 40 times the mass of our sun.

"So we measure the masses of the nearby black holes, understand their features, then look further away and see how much those further ones appear to have shifted," says Ezquiaga, a NASA Einstein Postdoctoral Fellow and Kavli Institute for Cosmological Physics Fellow working with Holz. "And this gives you a measure of the expansion of the universe."

The authors dub it the 'spectral siren' method, a new approach to the 'standard sirens' method which Holz and collaborators have been pioneering. (The name is a reference to a 'standard candle' method also used in astronomy.) The scientists are excited because in the future as LIGO's capabilities expand the method may provide a unique window into the 'teenage' years of the universe - about 10 billion years ago - that are hard to study with other methods.

Researchers can use the cosmic microwave background to look at the very earliest moments of the universe and they can look around at galaxies near our own galaxy to study the universe's more recent history. But the in-between period is harder to reach and it is an area of special scientific interest. The other advantage of this method the authors say is that there are fewer uncertainties created by gaps in our scientific knowledge.

"By using the entire population of black holes the method can calibrate itself directly identifying and correcting for errors," Holz says. The other methods used to calculate the Hubble constant rely on our current understanding of the physics of stars and galaxies, which involves a lot of complicated physics and astrophysics. This means the measurements might be thrown off quite a bit if there's something we don't yet know.

Every transfer move made a new beginning, we had no control whatsoever. Packing and unpacking were a part of the journey. Trunks were painted and stenciled to perfection. Luggage was opened in spells and stored in yards. We knew the odor of naphthalene balls.

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There was an excitement in exploring dad's gizmos in his Academy trunk. It contained a blue patrol side cap, a dagger, used scarf's, anklets, camouflaged jacket, tactical backpack, camp kit, poncho, b/w photographs and stationery, golf tees, binoculars, mess tin, précis and notes, holster, cane, jungle boots, slings, OG jersey to OTA tie including old gifts and souvenirs that were never opened. We lured his old DMS and handmade ankle boots. Dad was hardly seen around, although his homecoming was celebrated and rejoiced. He loved bluffing us with his thumb removing and longer finger tricks.



Wg Cdr Siddharth Kharbanda

Back in the 80s, when dad was GE at Ichhapore, a census town in Barrakpore near Calcutta, we never expected to be housed with so many rooms of which many remained unexplored. The house, 47 The Park, was dubbed to be the official residence of Lord Dufferin. It had the furniture of Mahogany. The compound had several tamarind trees. Later, in Ranchi, families lived in the close-knit association of regimental brethren. Faith was relied on with trust and loyalty. The arm of Sappers was known for a unique family spirit, bound by a community of relentless pursuit, with intimate social and cultural ties. The families relished and lived each moment with timeless tales to cherish even today. When societal roles took birth, we lived each day enjoying a bond that we fondly remember to date.

Each child knew to ride a bike, swim, dance, skate and strum an instrument, run, hike, trail and trek, the hard way! Of course, we could scale heights. Drama and declamation was our potent force. You name it and we could do it. Nothing was a Waterloo. Exploration was deep-rooted. Hobbies were plenty and interests were countless. Small scaled discoveries and inventions were copyrighted. Discipline and decorum were a part of life. We were hardy and upright. We had roots cultivated deeply in the military culture, planted swiftly and surely. We were quintessential. This gave way to a larger belief and greater good of succeeding in all facets of life. It assured us of doing things right. We were resilient, rather antifragile. There was never an age bar to making friends. Older children played the role of mentors. Experiences were varied and exposure was phenomenal. It was a way of life, accepted as a blessing of indoctrination and grooming. It taught us to accept challenges, face hardship, be flexible and live a life less ordinary. Happiness was found in the smaller things and in the

modest path we took.

Wheels

Let me begin this autobiographical narration with the wheels with which we were always fascinated. It was the establishment of the MT, perceived as 'empty' at close quarters. The Jonga and the Jeep that once rolled the high altitude were rugged and all-terrain utilities. The Japanese Nissan machines housed a 4x4 abode. The 4WD lever was thought to be a magic tool. The gun carriage assembly produced a peculiar sound of road friction. Snow-clad traction with chained wheels was a normal phenomenon. Common vahan entailed muscular, Nissan one-ton goods carriage. It was a sight to imitate the front manual ignition. 'Shaktiman' emboldened three-ton. Awe-inspiring convoys included multi-beaconed Tatra trailers ferrying tanks. Matadors were still in use. Hindustan's Ambassador the king of Indian roads. The DR (Despatch Rider) always made his bullet a royal two-wheeler. Gasoline always rewarded the brain and activated the pleasing mesolimbic pathway.

Born in MH Roorkee, there is always an attachment to the place of birth. It was home to Bengal Engineering Group (BEG) & Centre, founded in 1803, as King George V's Own Bengal Sappers and Miners with its motto 'God's Own'. Situated at Gobindgarh village gave a better understanding of livelihood. These memories had an impressionable impact that is still crystal clear. Every move transfer made a new beginning, we had no control whatsoever. Packing and unpacking were a part of the journey. Trunks were painted and stenciled to per-

fection. Luggage was opened in spells and stored in yards. We knew the odor of naphthalene balls. It reminded us of the exact location of a treasure trove. Canvas bedding rolls with tightened buckles were carried during journeys. There was an excitement in exploring dad's gizmos in his Academy trunk. It contained a blue patrol side cap, a dagger, used scarf's, anklets, camouflaged jacket, tactical backpack, camp kit, poncho, b/w photographs and stationery, golf tees, binoculars, mess tin, précis and notes, holster, cane, jungle boots, slings, OG jersey to OTA tie including old gifts and souvenirs that were never opened. We lured his old DMS and handmade ankle boots. Dad was hardly seen around, although his homecoming was celebrated and rejoiced. He loved bluffing us with his thumb removing and longer finger tricks.

We moved to Ranchi by train that was an epic journey in itself. The first-class bogies housed families and pets. Train Adjutant authorized train stoppages that allowed families to recoup the spirit of camaraderie. We had a dear affinity with the erstwhile Inland and the postcard. The essentials. Accommodation ranged from mud houses, temporary scaled quarters to colonial-era bungalows that had outlived their time. Polishing mementos were insisted. The inventory ranged from camel chairs, study tables, lampshades, cane and iron swings. Antique charpoy were used as trampoline till the netting gave way. Jute mat, horns, pot planter, flower vase, saddle, hammock, brassware, sword, hand-craft, woodcraft, shell-based table lamp, ashtray, artistic drift-wood were prized possession that eased homely interiors. Cap stands were a scaled fitting. MES sofa with super spring cushion was a traditional luxury. Trunks were used to make settees padded with bolster pillows. Carpets were mandatory possessions. Peg tables had embroidered covers were bought from the Old Market in Calcutta. Glass flamingos pecked on a timer. Few owned aged skulls, brass metal, cuckoo clocks and other artistic wall hangings. Mothers used hand-held fans made of bamboo strips and mulberry paper. Cutlery was widespread. Bars were old-fashioned with imported glassware to serve beer, wine and scotch. Handcrafted

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Dehradun
The next lucky leg was a home tenure to Dehradun. We stayed with our grandparents. Our grandmother was the President of the Arya Samaj. Everyone got hold of her vocal recording with major shlokas for conducting a havan. They were obligatory and participatory within the joint family. We firmly believed and preached the values of karma. We visited the Jhandewala wherein the legacy of Guru Ram Rai was carried forth by Shri Mahant Indresh, who lead a life of celibacy and dedicated his life to the noble cause. We were fond of iconic drama plays like Dhooop Kinarey, Nijaa, Tanhaiyan. Adjusting the TV antenna was a forlorn conclusion. We visited Mussorie, Sahastradhara, Haridwar, Shiv Mandir, Malsi Deer Park, Lachhiwala, Ghari cantonment.

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#FAUJI LIFE

This Life Was Priceless!



Fort William, Kolkata.

The inescapable entity was a sahayak, a buddy, a friend, a mentor, a guide; we fondly called 'bhaiya'. He was Man Friday. Going to school on his 'Hero' bike was routine. We still fondly inquire about his well-being. Life was never a place so woe-begone. We rather made every place a distinct part of our personality. In Abohar, we lived in mud houses (known as Basha) adjacent to the Sirhind canal. The environment gave a deeper meaning to life amongst the suburbs of the Fazilka border. Mess premises became common playing grounds. The flank of houses connected outer premises through a foot-bridge. Once, houses caved in during incessant rains and the canal water overflowed. We communicated using sound waves that travelled on wool made with matchboxes using NATO call signs with transcripts to 'perfect' telephony. Interacting with the local populace at Gobindgarh village gave a better understanding of livelihood. These memories had an impressionable impact that is still crystal clear.

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liqueur, homemade wine and show-piece miniature bottles were common.

'Jai Ho'
Times spent at Deepatoli were regimented. Functions were combined and conducted by the team of 'Sahas Aur Yogvata'. The clan of 53 Engers was known as 'Mauij's', named after Maj Gen S Majumdar (Retd), its first CO. 'Sarv Dharm Sthal' was statutory. Mandir parades and visit to the Gurudwara were regular and pious. We studied at Bishop Westcott Boy's School at Namkum. Toys were wooden and limited and preserved. 'Rover', our Doberman, was trained to run along our white Lambretta. He could predict the seismic activity and one day he barked before we felt the tremors. He was an unmatched companion. He was trained to fetch the newspaper and even thwarted two burglaries. We embraced nature with grandma remedies and wore hand knitted cardigans. We witnessed car rallies that trespassed the outskirts of the unit. Classic animations were centrally screened in Anteroom on the VCR. Outings were on postluck. Mothers were engaged in event management, unit picnic and playing croquet. YOs played a pivotal role in laying the foundation of teamwork, humor and anecdotes being mischievous, playful and full of vigor. We fondly confer their glory and share good times. Holi was made special by their stint of pranks and tricks. The quarter guard gave shivers. On posting regiment officers bid goodbye while Jawans garlanded train bogie with marigold. The officer was garlanded and was hailed 'Jai Ho'.

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IMA, and the FRI with umpteen trips. We enacted in-house drama plays. Tambola was inevitable. Sundays were spent watching epics as a part of morality and upbringing. Dad was more than accustomed to the nook and corner of the township.

Sugarcane stalks were chewed as a regular snack. Elloras in Rajpur Road was a known cornerstone. Our grandfather was a major shareholder in Anupam Shawis, in addition to working for LIC. Dehradun valley seemed truly picturesque at night. We were amazed at the constellations and learned the constellations that gave us a prelude to the zodiac. Mussorie was synonymous as nestled in the Himalayan heaven. We purchased a Maruti 800, with a prominent front bumper. Many bought the Japanese version of 1984 with a rear windshield opening as a distinct feature.

I spent a brief stint at the Carman School where I once figured as the father of three daughters in the famous story of 'Beast and the Beast'. We subsequently moved to St Thomas's College, located at the Cross Roads. The school was headed by Mr RV Gardner, who happens to be the Principal to date, with highly regarded faculty that 'Build Ye High and Build Ye True'. Life was colourful in black and white, as well as full of simplicity. Memories were relived through musical photo albums. Afternoon plays commenced with Doordarshan's all time classic signature montage.

Flying kites, cycling the narrow lanes of Khurbura Moholla, visits to Bijapur canal, venturing to the Bindal Rao, Joy ice cream factory, Kanwali Road, Paltan Bazar, Philatelic Bureau, English Book

Houses were named after famous mountain peaks. We participated in Bahai and NCSM meets. Puns were intended and satires were ironical. School recess included sponsors for the canteen and peg bottles from the military dairy farm.

Depot at Rajpur, Asiad and Gemini Circus at the parade ground, witnessing offices of Lavana set ablaze during Dasherra made the routine chores. Years of unimagineable monkey business and family gossip, an insatiable lust for mischief and the family life affirming addition to joy. New Year's Eve was celebrated with Usha Uthup's melody and the everlasting endearing charm. In the earlier days, teenage boys from the Jalpaiguri district in the East came for work and to join the armed forces. We got two Gorkhas, the former of which got enrolled. We knew the train tracks, linkages, connectivity and timings on our fingertips.

Kanpur
Kanpur had our maternal roots close to Arya Nagar and Swaroop Nagar. Grandparents taught us rituals, to be independent and to muster the energy to strive for excellence. They left thy halls forever never to

return; still within our hearts fond memories steadily will burn. Much of the linen, cotton ware and woolens in the house came from the heavenly spirits in a strange and mysterious board game Oujia. Tina Charles and Jim Reeves were timeless. Medium Wave played the forces' request. TV drama 'Oshin', the famous fictional biography of Shin Tanokora was timeless. Mythological stories of 'Vikram aur Beetal', Jaspal Bhatti's 'Full Tension' and 'Mungerli ke haseen sapne' featuring a small-time clerk were followed, so was 'Richie Rich' and 'Dadi's Comedy Show', a German show starring Dieter Hallervorden and his antics. Jesse Mach's 'Street Hawk' and David Hasselhoff's 'Knight Rider' were evergreen shows. Thanks to Neal Mariens's 'The Wonder Years' that infused in us the spoken language.

PC Sarkar's unexplained magic Calcutta was the city of joy. It had its sweet idiosyncrasies. British-styled mansions existed in Hastings. A Doberman, parrots, and school of fish did not get pet hoarding. The harbour was nearby so we frequently visited the jetty. We went for rides in tugboats to the anchored ships in the Diamond Harbour. Vidysagar Setu had commenced Calcutta bus, tram, metro and hand-pulled rickshaws. We played Tennis at the Ordnance Club. The city was known for its convent schools.

We ventured to Dulabari in the Jhapa district and enroute saw the Border Marker and 'no-man's land'. We got our hands-on Atari video games, cut glass and woolen blankets. Sports and swimming was a daily affair. We got the maiden exposure of the equestrian sport. Teachers took care of thorns and tiny blades during misadventures. Other therapies relied on homeopathy and throat paint for sores. Vintage car rallies were sought after. Statue was enacted when you needed something very precious. PC Sarkar's magic was unexplained but wasn't life less magical? We played the membranophone percussion, Tabla. We visited Mothers' House and Missionaries of Charity. Bus rides were most entertaining. Gumboots were worn to school. Incessant rains made marshy pastures. During one of our relocations, our luggage trailer truck got stuck in a similar bog. Eventually, the EME's 'Recovery' was pressed in. BD coy was witnessed live.

Calcutta was famous for its Fort William and its moot. Dad was in AWHO. Library services sustained at St Peter's Church that housed stained glass and rustic odor. We glanced through encyclopedias,



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rain and suburbs, of colossal flora and fauna with a fond collection of memories and yore. Distinct facets and mores of customs allowed us to unite easily. It dwelled us into a joint family with a landscape of an accommodating temperament confluence both in nature and signature.

Try walking in our shoes; you'll stumble in our footsteps. Unless you've lived these times, you will not get it. It's not a choice but a chance that you are just born that way. "Sow good services and sweet remembrances will grow from them," rightly quoted by Madame de Staël. That's a title, a group of us of the same boat, commune and fraternity. The transition from a generation to the next as reminisced in prose autographed in a diary was a challenge to better our ways. We were unpretentious, yet good-looking. We were both saviours and survivors. We fondly experienced, silently shared, sympathetically empathized, relate to and were thankful for lifelong memories. This bond was of tacit understanding and implicit vibes. These were just a glimpse few of the reminiscence. This life was priceless!

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Calcutta was famous for its Fort William and its moot. Dad was in AWHO. Library services sustained at St Peter's Church that housed stained glass and rustic odor. We glanced through encyclopedias,

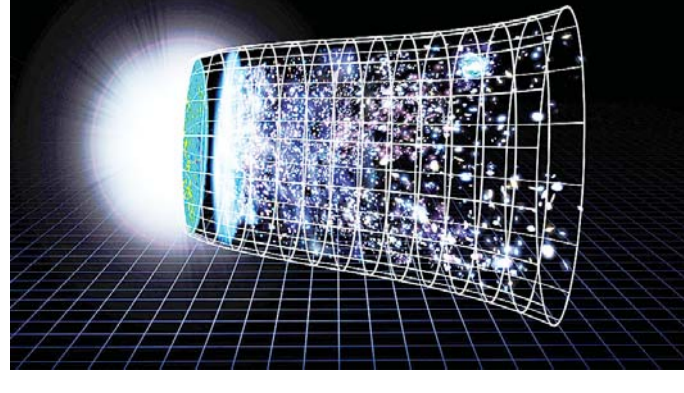
rain and suburbs, of colossal flora and fauna with a fond collection of memories and yore. Distinct facets and mores of customs allowed us to unite easily. It dwelled us into a joint family with a landscape of an accommodating temperament confluence both in nature and signature.

Try walking in our shoes; you'll stumble in our footsteps. Unless you've lived these times, you will not get it. It's not a choice but a chance that you are just born that way. "Sow good services and sweet remembrances will grow from them," rightly quoted by Madame de Staël. That's a title, a group of us of the same boat, commune and fraternity. The transition from a generation to the next as reminisced in prose autographed in a diary was a challenge to better our ways. We were unpretentious, yet good-looking. We were both saviours and survivors. We fondly experienced, silently shared, sympathetically empathized, relate to and were thankful for lifelong memories. This bond was of tacit understanding and implicit vibes. These were just a glimpse few of the reminiscence. This life was priceless!

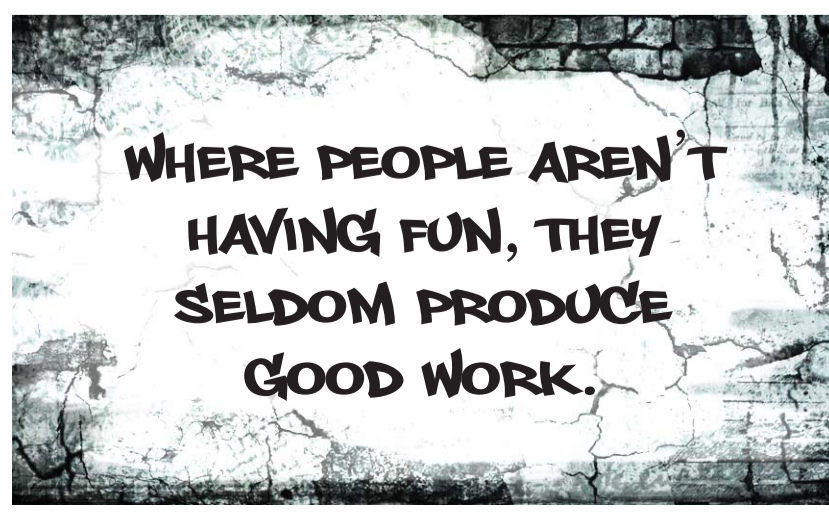
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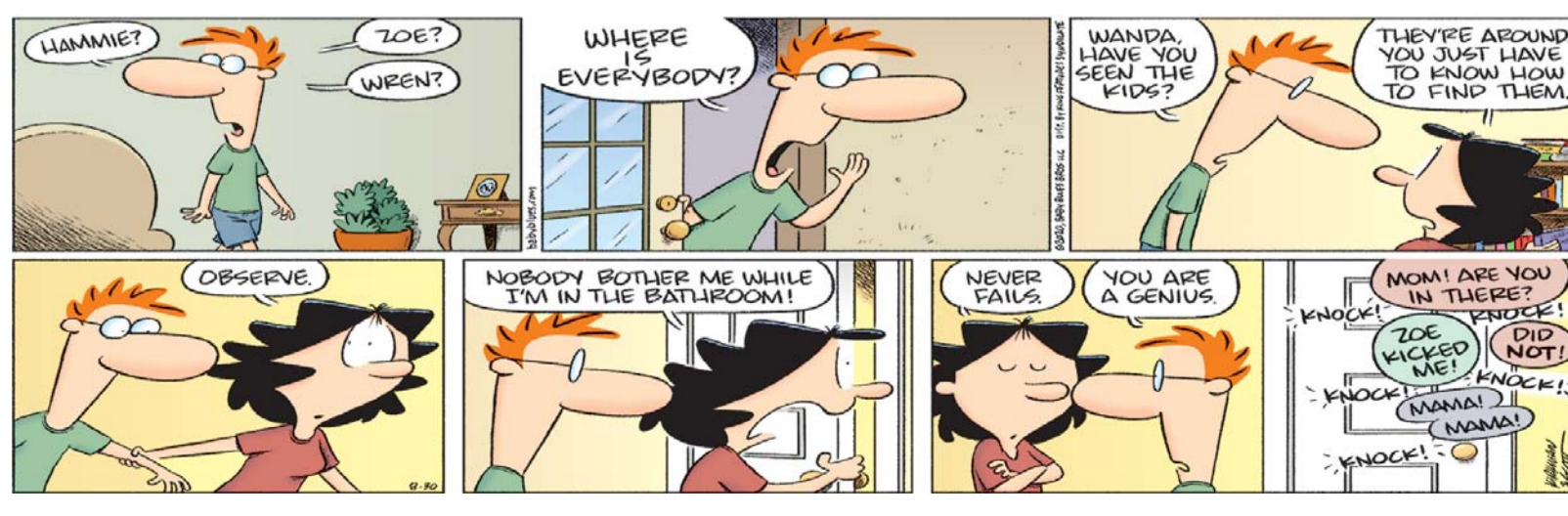
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THE WALL

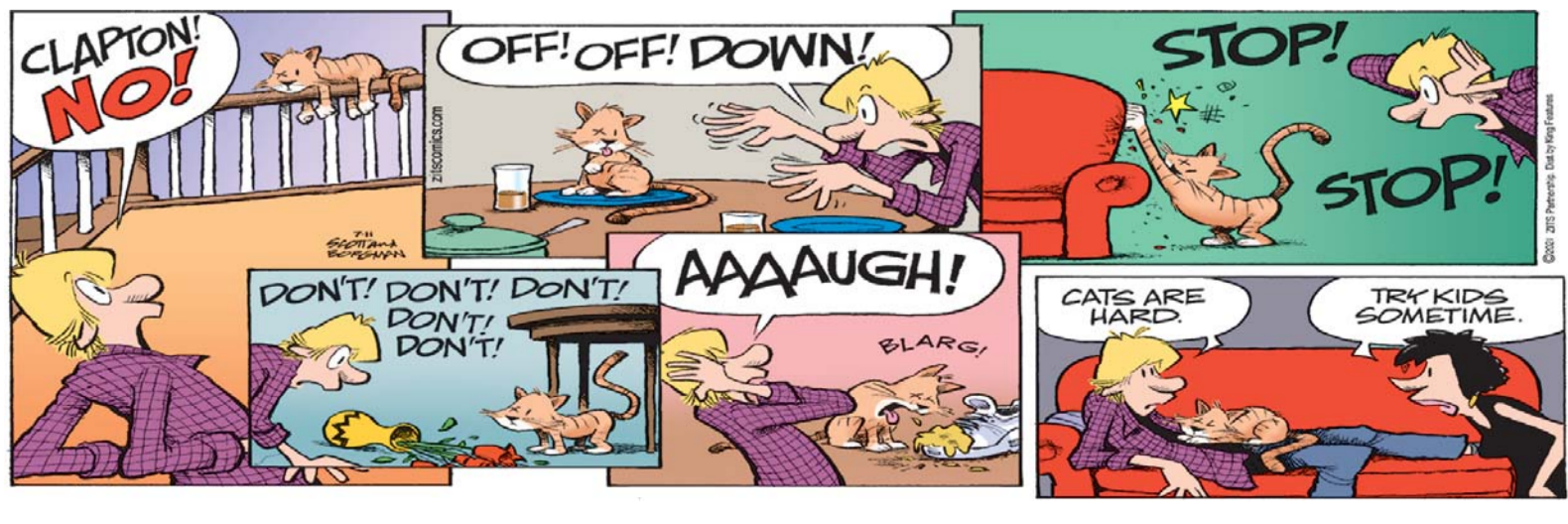


BABY BLUES



By Rick Kirkman & Jerry Scott

ZITS



By Jerry Scott & Jim Borgman