The Story of Jayn

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I want to tell you a story about Jayn. Jayn is an electron. Just one among countless others. There's nothing particularly special about Jayn, but Jayn plays an important role in our story.

At one point in Jayn's long life, without knowing it, Jayn would cause problems for me – but that's not where Jayn's story begins.

Jayn's story begins 13.8 billion years ago. Jayn popped into existence out of the emptiness, seemingly alone in the world. Well, not entirely alone. Surrounded by cousins and siblings, an ocean of elementary particles. There were quarks, there were electrons, and they all swam together in a sea of raw energy and matter.

Before long, the quarks got tired of floating around on their own. They clumped together, forming protons and neutrons – massive beasts compared to little Jayn. Jayn didn't like this new, crowded world. Jayn loved the freedom of zipping around the universe unbound. But eventually, Jayn felt a tug – a deep, irresistible attraction to one of those giant protons. And with that, Jayn became part of something new: a hydrogen atom.

Jayn lived in that hydrogen atom for billions of years. Over time, Jayn joined with other hydrogen atoms, coalescing into a star. Jayn basked in the warmth of the star's outer layers, content as the star burned brightly in the universe.

Eventually, though, Jayn's hydrogen atom drifted toward the star's core. There, something new happened. Instead of circling just one proton, Jayn now orbited two. A new proton had joined, forming helium. This meant there was space for another electron too – Jayn's first real companion.

They shared the same orbital space, something Jayn had never experienced before. Usually, if another electron came too close, one of them would yield into another energy state. But not this time. This was different. They could exist in the same place, with the same energy. How? Physicists would later call it "spin". Jayn didn't know what "spin" meant, it was weird, but Jayn liked it. It meant Jayn wasn't alone.

Jayn was happy in the helium atom, but the universe never stands still. Another proton came, then another, and eventually Jayn was part of a silicon atom, orbiting a nucleus with 14 protons and – of course – 14 electrons.

Jayn was no longer close to the nucleus. Now, Jayn was far out on the edge of the atom, in the outermost orbital shell. From there, Jayn could feel the presence of everything around – not just its own atom, but all the neighboring atoms as well. One day, everything changed. The star exploded – a supernova – flung Jayn into the universe.

For a time, Jayn was adrift. Not alone, but not close to anything familiar. Eventually, the gravity of a forming planet – the one we now call Earth – caught Jayn's atom. The silicon atom joined with other atoms, bound together by Jayn's shared orbital shell between the atoms. It was easier to share the electrons than to be apart. The allure of the other atoms wasn't strong, but it was always there.

Jayn spent billions of years as part of the silicon atom, tumbling through Earth's oceans, sometimes bonding with other atoms, sometimes drifting free. One day, Jayn washed up on a beach, part of a grain of sand. And there Jayn stayed for a long, long time.

Now and then, out to sea Jayn went, then returned, living a simple, chaotic, quiet life.

But even quiet lives face change. One day, scooped up in a bucket, melted down, and turned into something new. Melted just meant more energy, Jayn had experienced that before, just more vibration. Sometimes, because of the vibrations, Jayn even had enough energy to escape the atom briefly before settling back down. But this time was different.

This time, Jayn became part of something incredibly uniform: a crystal lattice where every atom was another silicon atom, each in perfect order, with each atom sharing it's four outermost electrons in orbital shells with the neighbors. For the first time, Jayn could feel the full, equal pull of the electrons and nuclei around – like an invisible ocean of charges. It was electrifying.

Then one day, it happened. Another electron struck. It hit hard, and knocked Jayn from the orbital shell. For a brief moment, Jayn was free. Jayn flew through the crystal lattice, disoriented, then through something that was not a crystal lattice, but rather a jumbled mess of crystal pieces, until Jayn found another open spot, an empty energy state, where Jayn could settle again. It was strange but exhilarating.

And did you know? The presence of just that one electron – Jayn – in the gate oxide of a transistor was enough to shift the threshold voltage, change the flow of bias current, alter the frequency of an oscillator, cause my phone to lose the Bluetooth link to my door lock, and made me swear a number of times until the Bluetooth link finally reconnected, many, many, many seconds later.

And yet, Jayn's story doesn't end. Because Jayn, like all electrons, never really ends. Jayn may pop in and out of existence, but is always there – unchanged, identical to all the siblings.

The only differences between the electrons are where they are, their momentum and yes, their "spin". They are responsible for all chemical reactions in the universe. And their path through space-time described by the complex mathematics of the Schrödinger equation. Or if you want to include relativity, the Lagrangian of Quantum Electrodynamics.

So ends the story of Jayn – our 13.8 billion-year-old trouble-maker.

Carsten Wulff received the M.Sc. and Ph.D. degrees in electrical engineering from the Department of Electronics and Telecommunication, Norwegian University of Science and Technology (NTNU), in 2002 and 2008, respectively. During his Ph.D. work at NTNU, he worked on open-loop sigma-delta modulators and analog-to-digital converters in nanoscale CMOS technologies. In 2006-2007, he was a Visiting Researcher with the Department of Electrical and Computer Engineering, University of Toronto, Toronto, ON, Canada. Since 2008 he's been with Nordic Semiconductor in various roles, from analog designer, to Wireless Group Manager, to currently Principle IC Scientist. From 2014-2017 he did a part time Post.Doc focusing on compiled, ultra low power, SAR ADCs in nanoscale technologies. He's also an Adjunct Associate Professor at NTNU. His present research interests includes analog and mixed-signal CMOS design, design of high-efficiency analog-to-digital converters and low-power wireless transceivers. He is the developer of Custom IC Compiler, a general purpose integrated circuit compiler, and makes the occational video on analog integrated circuits at https://www.youtube.com/@analogicus. For full CV see https://analogicus.com/markdown-cv/.