LETTERS TO PROGRESS IN PHYSICS

Pierre-Marie Luc Robitaille: A Jubilee Celebration

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We celebrate the 50th birthday anniversary of Prof. Pierre-Marie Robitaille, the author of Progress in Physics who is one of the leading experts in the Nuclear Magnetic Resonance Imaging. Prof. Robitaille is known as the designer of the most world's first Ultra High Field MRI scanner. Prof. Robitaille still continues his creative research activity in the field of thermal physics, connected to the origin of the Microwave Background and astrophysics.

July 12, 2010 marks the 50th birthday of Professor Pierre-Marie Robitaille. He was born in North Bay, Ontario, the third of ten children to Noel Antoine Robitaille and Jacqueline Alice Roy. Noel Robitaille had moved to Ontario from his native Quebec when he was stationed as a physician in the Royal Canadian Air Force. Eventually settling in northern Ontario, he served the villages of Massey and Espanola. In his role as a local doctor, Noel Robitaille would also care for the Ojibway population of the region. In 1964, he would be honored by the Ojibway Nation, becoming the first white man to bear the distinction of Ojibway chief of the Spanish River Band. His Indian name, *Ke-chutwa-ghizhigud*, meaning "Chief Holiday" [1].

Raised by French-Canadian parents, Pierre-Marie Robitaille attended L'École St. Joseph in Espanola, Ontario, where he studied primarily in his native tongue. Upon completion of the 8th grade, he attended Espanola High School, where education was conducted in English. As an adolescent, he often served as an altar boy during daily mass at St. Louis de France Catholic Church, the French parish of his community. Surrounded by the forests of Northern Ontario, he enjoyed ice fishing, hunting, and building log cabins in the woods.

In 1978, just as Robitaille was completing his secondary education, his father relocated to Cedar Falls, Iowa. Mrs. Robitaille and her children were to remain in northern Ontario. In order to maintain ties with his father, Robitaille enrolled at the University of Iowa in Iowa City. It was there that he met his future wife, Patricia. Though he relocated to Iowa for the 1978–1979 school year, Robitaille rarely saw his father. Therefore, he moved to Cedar Falls, Iowa. He would graduate from the University of Northern Iowa, in 1981, with a degree in general science.

At that time, Robitaille entered a Ph.D. program in biochemistry under the tutelage of Dr. David E. Metzler at Iowa State University, obtaining an M.S. degree in 1984. His masters thesis involved NMR equilibrium analysis of polyamines with vitamin B6. At the same time, Robitaille realized that in-vivo NMR was beginning to grow. He sought unsuccessfully to convince Dr. Metzler to enter this promising new area of biochemistry and, eventually, entered the field on his own.

Prof. Pierre-Marie Robitaille.

He transferred his graduate appointment to the Department of Zoology, where he brought in-vivo NMR methods to the laboratory of George Brown, an electron microscopist. It was there that he acquired a set of standards for in-vivo ^{31}P-NMR [2] and conducted some of the first studies of isolated sperm cells with ^{31}P-NMR [3, 4]. At the same time, Robitaille enrolled in the Inorganic Chemistry doctoral program, under the guidance of Professor Donald Kurtz. He graduated from Iowa State University with a Ph.D. in 1986, holding majors in Zoology and Inorganic Chemistry. His dissertation was divided into two parts which he would defend in front of separate committees, one for each major.

Following his Ph.D. training, Pierre-Marie Robitaille joined the in-vivo NMR laboratory of Professor Kamil Ugurbil at the University of Minnesota. There, he conducted work in cardiac spectroscopy, operating one of the first small animal 4.7T/40cm magnetic resonance instruments in the United

States. It was Professor Ugurbil who urged Robitaille to apply for faculty positions in magnetic resonance imaging and spectroscopy. Ultimately, he accepted the position of Director of Magnetic Resonance Research and Assistant Professor of Radiology at The Ohio State University, with a startup package well in excess of $1 million. He was 28.

While at Ohio State, Professor Robitaille established himself as a leader in cardiac spectroscopy and magnetic resonance [5, 6]. He would eventually design and assemble the world's first Ultra High Field MRI instrument [7–16]. The results obtained from this scanner would propel MRI into a new era in imaging technology. Professor Allan Elster, the Editor of the Journal of Computer Assisted Tomography recognized the magnitude of the contribution and arranged for a special issue of the journal to be published outlining some of the first 8 Tesla results. In is editorial comments relative to this issue, Dr. Elster wrote:

> "This is a landmark issue of the Journal of Computer Assisted Tomography. Contained within its pages are amazing images and technical descriptions of the world's first whole body human clinical magnetic resonance scanner operating at 8 Tesla. Congratulations to Pierre-Marie Robitaille and his co-workers in Radiology and Engineering at The Ohio State University for constructing a device some experts said would be impossible to build. The total stored magnetic energy in this 30,000 kg magnet is a remarkable 81 megajoules. To put this value into perspective, 81 MJoules is the kinetic energy of a 200-metric ton locomotive barreling down the track at 100 km per hour! The human images obtained so far are also astounding (Fig. 1), especially considering that the system has only been operational for a few months and many radio frequency coil and pulse sequence issues remain to be worked out. The Ohio State team has proposed a number of interesting theories concerning susceptibility effects and dielectric resonance phenomena within the human head at 8 Tesla. Some of these theories challenge traditional tenets in MR physics and are admittedly controversial. As more measurements are obtained and experiments are conducted, these theories will be refine, improved, or discarded. Robitaille et. al. have led us to a new frontier in clinical MR imaging. Perhaps one day in the not-so-distant future, 1.5 Tesla will be considered low-field imaging" [14].

The next month, Professor Robitaille established a new record for high resolution imaging in MRI, once again published in JCAT, with the following editorial note:

> "Pierre-Marie Robitaille and the Ohio State University MRI Team have done it again! In this issue they present the world's first MR images obtained at 2,000×2,000 resolution — in honor of the new millennium of course. In case you missed it, please check out the Journal of Computer Assisted Tomography's November/December 1999 issue. Here Robitaille and colleagues have published 10 landmark articles describing the design and construction of their 8 Tesla whole-body MR scanner, as well as additional remarkable images of the brain. If you wish to download some of the images directly (they look even better on a video monitor), please see the JCAT website at www.rad.bgsm.edu/jcat/supp.htm. Happy Y2K from all of us at JCAT!" [15].

The birth of Ultra High Field MRI represented a paradigm shift for many in the MRI community who had previously believed that human images could never be acquired at such field strengths [16, 17]. Relative to the creation of the first UHFMRI systems, Paul Lauterbur (Nobel Prize in Medicine and Physiology, 2003) wrote:

> "In the early machines, low radiofrequencies of 4 MHz or so meant that RF coil designs were simple (even inexperienced undergraduates could design and build such circuits with little knowledge of more than DC electrical circuits), and the forces on gradient coils were small. The effects of magnetic susceptibility inhomogeneity in and around the object being imaged were negligible, and RF penetration depths were not a problem for human-scale samples. Everything began to change as higher fields and higher frequencies came into use, and the earlier idyllic simplicities began to seem quaint. The trend continued, however, driven by the increased signal to noise ratios and the resultant higher resolution and speed available, and sophisticated engineering became more and more essential, not only for magnets but for gradient systems and radiofrequency transmitters and receivers, but also for better software for modeling and correcting distortions. Experts who had said, and even written, that frequencies above 10 MHz would never be practical watched in amazement as scientists and engineers pushed instrument performances to ever-higher levels at ever-increasing magnetic field strengths, as this volume demonstrates" [18].

Prior to assembling the 8 Tesla instrument, Professor Robitaille envisioned that his career would remain firmly grounded in MRI. However, the first results at 8 Tesla relative to RF power requirements in MRI profoundly altered his scientific outlook. He began to think about MRI as a thermal process. In the early days of NMR, the T1 relaxation time was referred to as the "thermal relaxation time". As a result, Professor Robitaille advanced the idea that, if MRI was thermal process, it should be possible to extract the temperature of the human head using the laws of thermal emission, in the same manner that Penzias and Wilson had measured a temperature of ~3 K for the microwave background [19]. Unfortunately, such an approach yielded a Wien's displacement temperature of less than 1 K for the human head. Surely, something was incorrect.

Professor Robitaille viewed magnetic resonance as enabling scientists to examine the reverse of the emission problem in the infrared, as studied by Planck and his predecessors [20]. Therefore, he turned his attention to thermal radiation and astrophysics. Soon, he published an abstract which questioned the assignment of the microwave background to the cosmos [21]. Then, in a bold step, he placed an ad in the New York Times [22] announcing the Collapse of the Big Bang and the Gaseous Sun. The response from the popular press and the scientific community was immediate and sometimes harsh [23–25]. Despite claims to the contrary [23], Professor Robitaille's advertisement in the New York Times had nothing to do with the concurrent debate in Ohio relative to evolution [23]. The timing was purely coincidental.

Following the ad in the New York Times, Professor Robitaille turned to Progress in Physics and began outlining his ideas in a series of papers which spanned a very broad area of fundamental physics. His papers on the WMAP [26] and COBE [27] satellites are amongst the most viewed by the journal audience and, eventually, his position was found to merit some consideration by the astrophysics community [28].

The study of Kirchhoff's Law of Thermal Emission has been the driving force behind Prof. Robitaille's work in astrophysics. Robitaille has demonstrated the invalidity of this law and its subsequent claims for universality [29–33]. Prof. Robitaille has also argued that the proper analysis of thermal emission should be attributed to Balfour Stewart [32]. Resting on the knowledge that Kirchhoff's Law was invalid, Robitaille argued for a liquid model of the Sun [34] and advanced simple proofs to strengthen his position [35]. Robitaille maintains that the emission of a thermal spectrum from the Sun, by itself, comprises all the proof necessary for a liquid model. Given the error within Kirchhoff Law, the Sun cannot be a gaseous plasma. It must be condensed matter.

Robitaille has also based his re-assignment of the microwave background to the Earth on Kirchhoff's Law [28]. He has shown that astrophysics did not properly consider the emission of water itself when contemplating the background [36, 37]. His recent paper analyzing the Planck satellite [38] further builds on his position, along with papers by the authors, Rabounski and Borissova [39]. Finally, Robitaille has questioned the validity of Boltzmann's constant [40]. This is the result of the correction of Kirchhoff's Law [28, 29–33] and the re-assignment of the microwave background to the Earth [36–39].

Robitaille maintains a quite lifestyle in Columbus, Ohio. He has been married to Patricia for 30 years, and they have three sons: Jacob, Christophe, and Luc. Dr. Robitaille enjoys sailing his Flying Scot and is an avid builder of timberframe structures.

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