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CAMBRIDGE, 1962.

WHILE IN CAMBRIDGE sitting the scholarship examinations I was the house guest, as I had been on several previous occasions, of Hubert and Joyce Linfoot. I had first been introduced to them by the Boss in 1959 or 1960 at one of his Cambridge affairs—at that time their son Sebastian attended Edgarley Hall, the Millfield junior school in Glastonbury. In bringing us together the Boss must have reckoned, with his usual sagacity, that the Linfoots, both mathematicians, and I, an aspiring one, would hit it off. How right he was! Hubert and Joyce became my mentors—surrogate parents even—and my debt to them is incalculable. They first invited me to stay during a school vacation in 1960; for a number of years after that I was to be a regular recipient of their hospitality.

As I have said, I had decided not to return to Millfield but to take up my Oxford scholarship the following October. By this time I had resolved to become a mathematician and so wrote to the authorities at Exeter College requesting that I be permitted to read mathematics, a proposal to which they agreed. Thus the question arose as to how I should fill the time—the best part of a year—before going up to Oxford. The Linfoots suggested that I spend the winter and spring with them in Cambridge, Hubert arranging for me to attend some lectures at the university. The Boss would then fix me up with a summer job which would carry me through until the following September. I was more than happy to accept these generous offers.

The Linfoots and their two children, Margaret, who was about my age, and attended the Cheltenham Ladies' College and Sebastian, a couple of years younger, lived in West House, one of two large residences in the Cambridge Observatories furnished by the university for the use of the John Couch Adams Astronomer and the Professor of Astrophysics. How handsomely the university then provided for its dons! The Observatory buildings, of Georgian foundation, are set in splendid grounds off the Madingley Road in the outskirts of Cambridge, next to what is now Churchill College (which I actually saw being built). At the time I stayed there West House had its own vegetable gardens and a spacious lawn which in the summer made an excellent badminton court. (Now, alas, all this has been dug up and covered with flimsy buildings, and the two residences converted into offices. *Sic transit gloria mundi.*) On the ground floor of the house was a generously proportioned drawing room, a separate dining room, and a large kitchen. The drawing room contained a number of bookcases containing a part of the Linfoots' extensive library: I recall that the books had been assembled on the shelves with the taller ones on the outside, so that the tops of their spines formed a concavity, pleasing to

the eye and at the same time minimizing the amount of sag in each shelf. (I have also adopted this method for arranging my books, but solely for aesthetic reasons.) Joyce and Hubert's library reflected the catholicity of their taste in literature: on their shelves one found everything from Lady Murasaki to Dashiell Hammett. After Hubert's death in 1982 Joyce generously allowed me to select a few of these books: in addition to Hammett's *The Maltese Falcon* and *The Glass Key* (in first editions) I chose Eddington's *Mathematical Theory of Relativity* (the very copy I had first used) and *Fundamental Theory,* Hardy and Wright's *The Theory of Numbers,* Hardy's two works on Ramanujan, and the first edition of Dirac's *Quantum Mechanics.*

The Linfoots led a cloistered life within a comfortable hermetic universe of the intellect, emblematic of a bygone and more refined age. Hubert's position as John Couch Adams Astronomer did not require him to teach, and so he rarely ventured beyond the Observatory precincts. His infrequent trips into Cambridge were usually made with the intent of replenishing his supply of cigars, one of which he would light up and puff with enjoyment after each lunch and dinner. Originally from Sheffield, Hubert was a short, bearded, brown-eyed, broad-browed man, some 55 years old when we first met. He had been an undergraduate at Balliol College, Oxford, where Henry Whitehead, the outstanding topologist, was an exact contemporary. A few years later the two competed for the single Mathematics Fellowship at Balliol, Whitehead emerging as the successful candidate. This had clearly been a great disappointment for Hubert, but he had at least the consolation of coming "second" to a mathematician whose originality and achievements he acknowledged.

Hubert was a polymath, capable of discoursing with depth and fluency on virtually any cultural topic. His life had been devoted to scientific work, to begin with in pure mathematics and later in mathematical optics and the design of astronomical telescopes. A true intellectual, he was a man for whom the life of the mind came as naturally as breathing.

He was highly musical and enjoyed playing the baby grand piano which occupied pride of place in the drawing room at West House. He also had a collection of records and pocket scores from which he would follow the music as it played on the gramophone. He had a great liking for the Beethoven quartets, to which he introduced me, his favourites being the F major, Op. 59, no 1 (the first of the "Razumovskys") and the A minor Op. 132, to which we would listen together in the recording by the Griller Quartet. I recall his enthusiasm for the recently released recordings by Kogan, Barshai and Rostropovich of Beethoven's String Trios Op. 9 in nos. 1 and 3. (I, too, was captivated by these performances, which were only to be surpassed, in my estimation, by those of Heifetz, Primrose, and Piatigorsky.) He was fond of Brahms's

chamber music, which, through him, I came to love also. But of all composers Bach ranked highest in his estimation, so high as to induce him to teach himself to play the preludes from the *Well-Tempered Clavier* on the piano. He also had a tape of Rosalyn Tureck playing Bach's *Goldberg Variations* which came as a revelation to me when I first heard it. He was not, however, particularly enamoured of 20th century music, and when I tried to impress him with *Petrushka* he responded by jokingly quoting the lines *The man who wrote the* Rite of Spring */ If I am right, by right should swing.* I also recall being puzzled by the fact that, while his collection of pocket scores contained a number of volumes of Mozart chamber music (works which I had not yet heard), he had no Mozart recordings, nor did he express any particular interest in Mozart's music. When I asked him about this, he told me that in his youth he had been fond of Mozart, but as he grew older he came to find that Mozart's music "lacked substance" by comparison with Bach, Beethoven and Brahms. In his musical tastes Hubert was very much an adherent of the "three B's."

An aficionado of literature, Hubert's favourite books included Tolstoy's *Anna Karenina* and Aldous Huxley's *Point Counter Point*, passages from both of which Joyce would read aloud in her pleasingly modulated voice. Despite being a confirmed atheist, Hubert was delighted by C. S. Lewis's *The Screwtape Letters*, which he thought one of the most brilliant books written by a religious believer. I recall that he also had a liking for Dashiell Hammett, particularly *The Maltese Falcon*, in which the "Flitcraft episode" had captured his fancy. In contrast with his indifference to modern music, he had an interest in 20th century painters such as Picasso, Ernst and Dali: the latter's *The Burning Giraffe* was one of his favourites.

Hubert's wit was of a striking mordancy. I remember him leafing through a catalogue of mathematics books and coming across the title "Calculus Refresher for Technical Men". He chuckled and said "Well, technically they may be men, but they can't do calculus!" And while Hubert was pleased when Joyce resumed her career of training teachers, at the same time he could not resist quipping: "Those who can, do. Those who can't, teach. And those who can't teach, teach teachers to teach." Most memorable was Hubert's pungent comment on the recent elevation of a contemporary of his to a professorship of mathematics: "In this country, once a mathematician becomes a professor, he has as much time for research as a bishop has for prayer."

Hubert was a very neat, precise man whose delicacy of touch enabled him to do his writing at a card table. (Being somewhat heavy-handed myself, my attempts at imitating him in this practice were a failure and so Joyce was kind enough to supply me with a solid wood table on which to scribble.) He was an excellent chess player and had

once been a member of the Oxford county team. Hubert also enjoyed playing the Oriental game of Go, which he had learned from one of his graduate students, a Japanese by the name of Yabushita, who had presented him with a handsome Go board as a parting gift. Hubert taught me to play this subtle game but always remained the superior player: despite a handicap of 5 stones I continued to lose.

Joyce, also originally from the Midlands, had been a wrangler (i.e., received first-class honours in mathematics) at Cambridge but, as with most women of her generation, had shelved her career to raise a family. Both she and Hubert were excellent linguists, she speaking fluent French, Hubert fluent German. As a Cambridge undergraduate in the 1930s she had won a university prize for reading aloud, a fact which would surprise no one hearing her beautiful diction. Her acute intelligence was combined with a deep kindliness, her natural gravity lightened by a sense of fun. She had boundless energy, and took pleasure in cycling, playing badminton on the spacious lawn in the Observatory grounds, and engaging in mock "table tennis" on the dining room table. She greatly enjoyed Contract Bridge, graciously tolerating my inadequate partnership in the many games we played after dinner against Hubert and Margaret. (I also recall playing countless games of double bezique with Margaret.) Joyce was an excellent cook, each day preparing, to Hubert's exacting standards, the meals to which she would summon us by the beating of a large gong in the front corridor. After her children had grown up, she resumed her career, becoming in 1962 a Lecturer in Education in Cambridge University, and in 1965 a Founding Fellow of Lucy Cavendish College, later serving for some years as its Bursar.

The months I spent in Cambridge during the first half of 1962 were some of the most delightful, and certainly the most intellectually intense, of my life. I attended some mathematics lectures in the university, the most important of which was Fred Hoyle's graduate cosmology course. As well as being a lecturer of brilliance, Hoyle was also a colourful character. Once I saw him roaring up the long drive to the Observatories in his sports car, skidding to a halt, jumping out, and rushing inside the building on some urgent mission. I was thrilled to be present at Hoyle's lectures, since I had read several of his books and, as one of the devisers of the steady-state theory[1], he was something of a hero to me. In his lectures, which were nothing short of *tours de force,* he described most of the cosmological models known at the time, including that of Kurt Gödel. It is curious that I, who was later to become a logician, should first hear of Gödel, the greatest of all logicians, in a cosmology course! Hoyle had mentioned that Gödel's

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[1] Most cosmologists were "steady-statesmen" up to 1965 when the rival "big-bang" theory was startlingly confirmed by the discovery of the 3°K. background radiation.

universe contained closed time-like lines, which meant that travel into the past was, in principle, possible. As a science fiction addict I was sufficiently intrigued by this idea to look up Gödel's original paper in the *Reviews of Modern Physics* (although I must confess that it did not make a great deal of sense to me). I took copious notes on Hoyle's lectures which on my return to West House I would write up in fair copy and submit to Hubert to go over. I modelled these notes on the contents of the impressive series of notebooks that Hubert had compiled over the years. These notebooks were beautifully written and a model of clarity, and I strove in my own way to live up to the standard they represented. (I made my first attempt at learning quantum theory by reading Hubert's notes on von Neumann's lectures on the subject at Princeton in 1929.) Looking back over my own notes on Hoyle's lectures, I am quite impressed at the apparent facility displayed by my 16-year-old self, but I still wonder whether I *really* understood what was going on. Certainly not to the same degree I later felt I had come to grasp modern abstract mathematics, to which I was able to make some modest contributions of my own.

While at the Observatories I also studied, under Hubert's guidance, Whittaker and Watson's *Modern Analysis*, Titchmarsh's *Theory of Functions* and Knopp's *Function Theory*. I strove to master contour integration, analytic continuation, and inversion of power series, but I never came close to equalling Hubert's command of these techniques. In fact the greatest influence on my development as a mathematician—such as it was—came to be exerted by my exposure to Kelley's *General Topology* and Loomis's *Abstract Harmonic Analysis*. Hubert had bought these books for the purpose of updating, through self-instruction, his own mathematical knowledge, which he realized had fallen behind since leaving pure mathematics for optics—I recall him remarking that, like me, he had always been an autodidact, a term I first learned from him. I borrowed Hubert's copy of Kelley's book and took to it immediately, the scales falling from my eyes as I began to see what it really meant to do mathematics from first principles. I started to work my way through the problems in this book, writing up some of my solutions and presenting them to Hubert. Kelley's book became my Bible, as it did for many other budding mathematicians of the time. From it I first learned not only general topology but also of set theory, lattices, Boolean algebras, topological groups, normed spaces. Kelley was my introduction to virtually every area of mathematics (apart from logic) in which I was later to work.

Although the authorities at Exeter College were agreeable to my changing my official topic of study from physics to mathematics, they pointed out to me that I lacked a foreign language 'O'-level, which, in addition to Latin, was required for entry to Oxford. I therefore resolved to work my Russian up to standard and take the examination in the

summer. I signed up for the Russian course at the local technical college, which I found very helpful. And, coincidentally, Joyce and Hubert were then both following the Russian course on BBC radio. So at mealtimes we often attempted to converse in our rudimentary Russian. When I finally came to sit the examination (briefly returning to Millfield for that purpose)—which mercifully I passed with the respectable, but hardly brilliant, score of 60—I recall making a fool of myself during the oral. Gesturing at the window, through which the Glastonbury Tor was clearly visible, the examiner asked me *Shto na kholmye*? ("What's on top of the hill?"). While I didn't know that *kholm* meant "hill", I might have had the wit to infer from the examiner's gesturing that that was the word's meaning. But no, instead I was reduced to repeating *Ya nye panemaiou* ("I don't understand"), a phrase which I am sure the examiner was tired of hearing. In any case I didn't know the Russian word for "tower" either!

A number of episodes from my days with the Linfoots have remained in my mind. On my first visit there (I must have been about 14) I recall that Sebastian lent me a small optical system, of which he was very proud, consisting of a lens seated snugly in a convex mirror, in which one could see one's own eye grotesquely magnified. While playing around with it I perversely rubbed the two glass surfaces together, in the process scratching them slightly, although I was unaware of this at the time. When I returned it to Sebastian, he noticed the scratches, and, very upset, took it to his father, who, in turn, came and confronted me with my misdeed. Of course I felt horribly embarrassed and apologized profusely. In a household in which lenses were cherished objects my careless act must have seemed nothing short of barbarous.

I recall on one occasion driving into Cambridge with Joyce in "James", the Linfoots' antique black Daimler. One sank so far into its comfortable leather-covered seats that only by sitting quite erect could one contrive to peer through its narrow split windscreen. While driving back along the Madingley Road the car suddenly lurched and ground crazily to a halt. To our astonishment we saw one of the tyres spinning off on its own trajectory into a neighbouring field, narrowly missing several startled pedestrians. It transpired that Joyce had recently had the tyres changed at a local garage, whose mechanic had evidently failed to tighten up the wheelbolts properly. For this negligence Joyce merely delivered a typically mild British reproof to the garage manager, in sharp contrast with what would have happened in the United States, where the firm would probably have been sued out of business.

Then there was the unique occasion on which Hubert was persuaded to go to the movies. We all piled into James and drove to the Arts Cinema in Cambridge to see David Lean's 1945 film *Brief Encounter.* For Hubert and Joyce this quintessentially English film

must have revived memories; for my part, I am afraid that I found it intolerably mawkish (I still do!).

Finally I relate the following tiny but significant episode. One evening before dinner I was listening in the drawing room to a radio performance of the first of Beethoven's "Razumovsky" quartets Op. 59. About halfway through the quartet's sublime third movement the gong was struck for dinner, but I was determined to hear the rest of the movement through. The fourth and final movement of this quartet happens to be based on one of the Russian themes which Count Razumovsky had enjoined Beethoven to incorporate into each of the three quartets he had commissioned. Now Hubert had remarked to me that Beethoven evidently did not take this aspect of his commission very seriously, since the (two) movements of the quartets containing Razumovsky's themes are the weakest (and indeed in the third quartet of the group Beethoven dispenses with Russian themes altogether!). Knowing that Hubert knew that I knew this, I sensed that he would expect me not to prolong my lateness beyond the bounds of courtesy by staying to listen to the quartet's anticlimactic last movement, but instead to join the company at table immediately after the third movement had ended. And that is what I did. As I sat down at the dinner table, apologizing for my tardiness, Hubert remarked that he was counting on me to show up at precisely that moment. I was pleased not to have disappointed him.

Reflecting on the time I spent with Hubert and Joyce, I am struck not only by their deep kindness and hospitality, their treating me as they would one of their own, but also by the fact that, despite our differences in temperament and outlook, they acted as if I was their intellectual equal. (This was also the way they treated their own children.) I was never talked down to, nor were their evident intellectual attainments ever used to impress their authority. From the beginning I revered Hubert and Joyce; I came to love them, and I always had the feeling that, filtered through their English reserve, my affection was reciprocated. I regard it as an honour to have known them.[2]

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From the sublime, I now descend in short order to the ridiculous. In his pursuit of advantages for the pupils at his school, the Boss had arranged for several Millfield boys, including myself and P. D. Norton, to participate in a "training" exercise with an industrial firm, in this case an outfit called Tube Investments, Ltd., with headquarters in Birmingham. In the spring of 1962 I tore myself away from my beloved

[2] After Hubert's death in 1982 I was asked by Joyce to write Hubert's obituary for the London Mathematical Society. The purely biographical part of this is reproduced in an Appendix.

books and went up to Birmingham for this affair. I seem to recall that none of the participants took the proceedings very seriously—certainly P. D. and I failed to do so. We squirmed through a number of ineffably boring lectures on the subject of extruded steel tubes, at the end of which some bright spark got up and asked "Just exactly what is an extruded steel tube?", a question whose witlessness can hardly have impressed the captains of industry there assembled. But I managed to cap this idiocy. To give us some idea of how extruded steel tubes were actually manufactured, on the last day we were all taken to a steel factory and each of us assigned to a worker on the shop floor. This was the only time I have ever been inside a heavy industrial installation and I still recall the "booming, buzzing confusion" inside the place, with long steel cylinders being forced, clattering and groaning, through enormous whirring machines. An absurd figure in the baggy overalls with which I had been issued, I stood next to one of these machines watching the taciturn fellow charged with my supervision press an oily rag onto one of the rapidly spinning steel cylinders as it passed through the machine. The urge to imitate proving irresistible, I got hold of an oily rag of my own and followed suit. Needless to say, I lost hold of it almost instantly and watched with dismay as, adhering to the cylinder's surface, it spun its way crazily to the maw of the machine. But my "supervisor" caught it in time. Giving me a merited look of disgust, he pushed a red button, causing bells to clang and the machine to grind to a halt. Thus ended my brief and inglorious career as a factory trainee.

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In June or July of that year I left the womb of the Observatories to take up the summer job at Shell Research Centre which had been arranged for me by the ever-resourceful Boss. The research centre was located in one of Shell's plants at Ellesmere Port, on the coast not far from Liverpool. My job was to provide a statistical analysis of the "knock" patterns produced by exploding petrol in the cylinders of internal combustion engines. This was not a research topic I had a burning desire to pursue, but I was grateful for the £8 per week the job paid—hardly a princely sum, but nevertheless my first "regular employment". I had to bone up on statistics—not a subject that appealed to me particularly—very quickly. Brian Toft and "Aromatic" Arrow, my "colleagues" in the lab—seasoned veterans all—treated me with amused tolerance. One thing I particularly recall from my time there was the use of epoxy resin—the British trade name of which is "Araldite"—mixed with metal shavings to modify the internal geometry of the cylinders. For some reason this impressed me greatly, and epoxy resin has continued to loom large in my life to this day.

During my Shell employment I lodged at the YMCA—the "Old Palace"—in Chester, a pleasant old Roman town (the name deriving from Latin *castra*, camp) on top of whose fortifications one could still walk. The "Old Palace", a rambling building divided up into scores of poky rooms, had originally housed the local Bishop, and had seen better days. I made a number of friends during my stay there. One was Robert Padgett, whom I was to get to know better at Oxford. The friend of the time who stands out most clearly in my memory is Sid Houghton, a short, round-headed, beaky-nosed fellow employed as a chemist at Shell. He had a quirky sense of humour which I found most appealing. He seemed to be impressed with the fact that I was about to go up to Oxford as a mathematics scholar; I recall writing down a proof of the Cauchy integral theorem for him—why that, particularly, I now have no idea. One Saturday night he invited me along to a party in nearby Liverpool, at which I got thoroughly drunk for the first time in my life, vomited all over the premises, and had to clean up the mess I made the following day. I recall at some point finding myself in bed with the girl Sid had brought along for the evening, but I was too inexperienced in sexual matters—and too drunk—to do anything about it. Despite this, and my managing in the course of the evening's revelries to get into a drunken brawl with Sid—how he must have yearned to buy back his introduction to me that night!—afterwards all was forgiven and we remained friends. He must have been a very accommodating fellow, for I made a royal fool of myself on that occasion.

I made the acquaintance of two young Welshmen, Owen and Dai. Owen was tall, fair and pleasantly taciturn; Dai short, fair and amusingly loquacious. One weekend the three of us decided to go hiking in the nearby Welsh mountains. We spent what seemed days—actually it can have been no more than hours—scrambling up and down scree-covered slopes in the rain, to fetch up, parched and famished, in a pub in some remote Welsh village, with a jawbreaking name like Pontyllanffridgogogoch, where we consumed quantities of cider and ate the most delicious sausages we had ever tasted.

There was also an Irish fellow who was reputed to have overcome the monastic YMCA regulations governing admission to the premises of members of the opposite sex through the ingenious expedient of raising and lowering his girlfriend by rope through the window of his room. Whether he really carried out this operation I do not know. He introduced me to the Schubert C major Quintet, one of the few works of that composer I have taken to my heart.

In connection with music, I recall that for some reason I had come to the Old Palace without my precious record player and slender collection of—by then—well-worn records, entrusting them to the care of the Linfoots. But it was not long before I began to find my musicless cell in the Old Palace intolerable. In desperation, I took the train back

to Cambridge to retrieve records and player, vowing that we would never again be parted.

It must have been around that time that I spent a few days in London with another cousin of my mother's, Jane Hyde-Thomson, whose father, Sir Dudley Colles, Extra Equerry to the Queen, was the "aristocratic connection" whose discovery by the British press had led to the unfortunate newspaper reports of my mother's death. I have a vague memory of being taken by my mother to tea with Sir Dudley at his London residence, which turned out to be no less an establishment than Kensington Palace! His daughter Jane lived alone—her husband having died long before—in a large flat in a block of apartments behind Barker's, the very store at which my dear departed mother had purchased the necessities for my admission to British society. I admired Jane for her cool intelligence; I sensed an affinity with her, feeling in some unarticulated way that our views of the world were fundamentally similar.

When staying with Jane in London I spent much of my time at the Gramophone Exchange, a record store on Wardour Street, where individual "kiosks" were provided in which their extensive range of discs could be sampled to one's heart's content. I recall that I first heard Pablo Casals's definitive 1936 recordings of Bach's cello suites there, returning again and again to play them on the premises until finally coming up with the money—I can't recall how—to secure their purchase.

I have one last memory of my stay in Chester that may be worth recording. One evening at supper in the Old Palace I found myself sitting next to a fellow I had not seen before. He told me that his name was John Pryce, that he was on a walking tour, that he was spending just one night here, and, on further questioning, that he was a mathematician in his second year at Cambridge. I was thrilled to learn that he was also the grandson of Max Born, a name I had long revered, and that in his knapsack he carried the manuscript of his grandfather's book on relativity, which he was revising for its second edition. After a while our conversation turned to general topology, which I was still attempting to learn from Kelley's book. Soon after he asked me where I was studying. I didn't have the guts to tell him that I wasn't yet officially at university, fearing that, were I to come clean on this score, I would appear ridiculous in his eyes. So I dissimulated, attempting to give the impression that I was already in my first year at Oxford. Many years later we were to meet again; when I mentioned our previous encounter in Chester, he said that he could not recall it. The episode looms large only in my mind.

At the end of my sojourn in Chester I was poised to assume a new position in British society. But this time I had no apprehensions whatsoever. For I was about to become an Oxford scholar.