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Dashing and Dutiful

Herschel and Maclear made a strange if effective team in their astronomical work at the Cape of Good Hope.

David S. Evans

The world is full of obscure people and obscure places which, when studied in detail and with sympathy, are seen to be worthy of a far wider fame than they enjoy. The two astronomers John Herschel and Thomas Maclear, well enough known, indeed, to the astronomical profession and "the Cape," where they worked together for four years, form an example of this.

The name "Cape of Good Hope" refers precisely to a most undistinguished point of land at the southern end of the Cape Peninsula, that appendage to the southwestern corner of the African continent whose northern end forms Table Mountain, with Cape Town nestling at its foot. "The Cape" also means, nowadays, the whole province of the Cape of Good Hope, which is—if the comparison is not impious—a little larger than Texas, and is one of the provinces of the Union of South Africa. Settlement of the Cape began in 1652 with the establishment of a "refreshment station" by the Dutch East India Company, for victualling their ships on the long haul round the Cape from Holland to their Far Eastern possessions. In time, this depot grew into a town, and the town into a colony, and the internal history of the region since that time has been one of steady expansion of the settled area into the interior.

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Early History

Even in very early days the Cape had a certain importance to astronomers. It was settled long before the marine chronometer made navigation at all certain, the weather in the region can be extremely rough, and it was by no means a difficult matter to miss the Cape completely, to find oneself lost in an angry southern sea. It became important, therefore, to fix the geographical position of the Cape as well as possible, by means of astronomical observations, and to observe the new constellations of the southern sky visible from it, to make them of use to navigators. Even before the establishment of any fixed observatory at the Cape, visits were paid by a number of astronomers, the most notable of whom was the Abbé de la Caille. Lacaille, as his name is usually spelt by modern astronomers, came in 1751 and spent two years in and around Cape Town, making astronomical and geodetic observations.

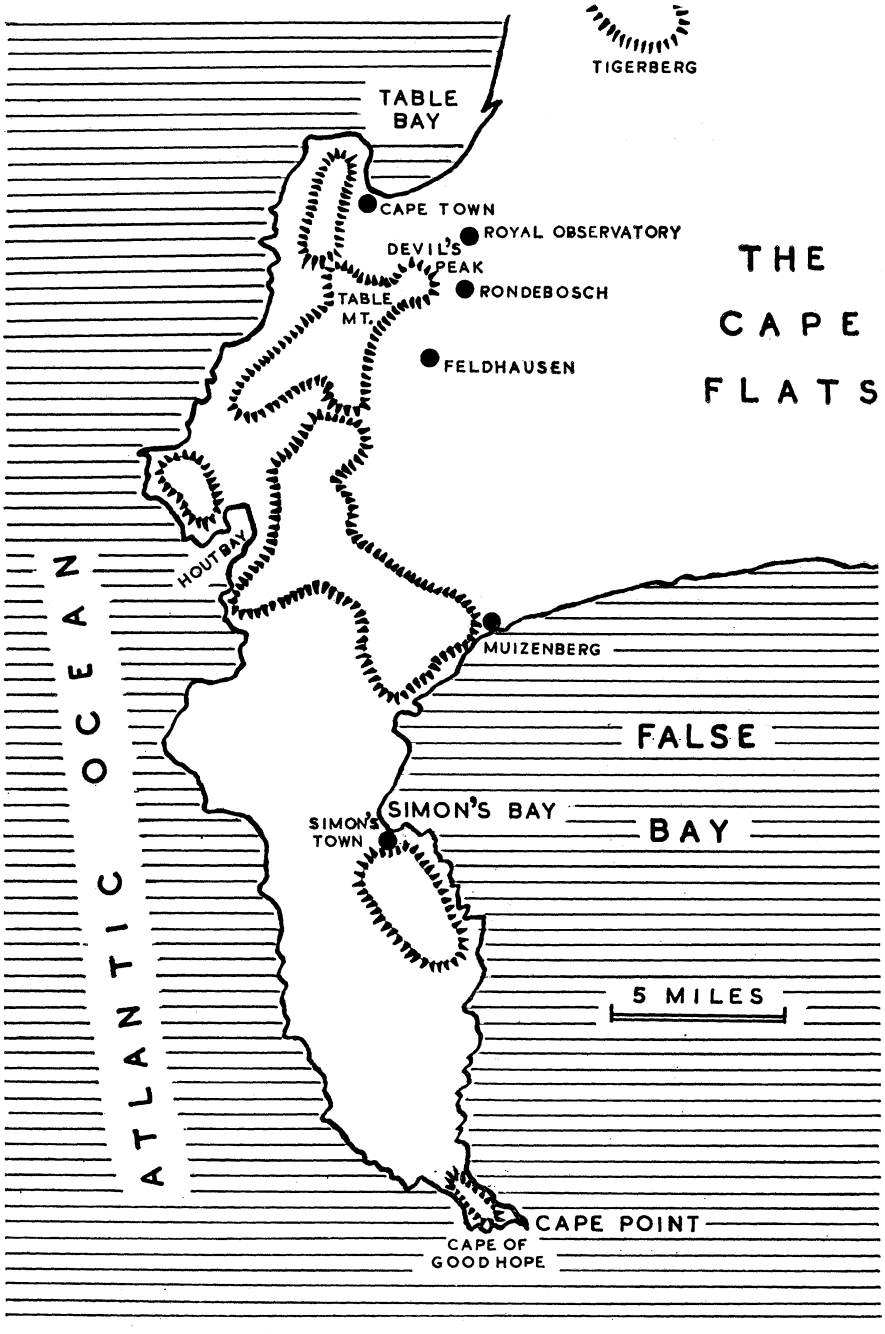
The choice of the Cape as the site for this expedition was a natural one, for not only was Cape Town one of the few European settlements far south of the equator but it was also the only one in the same longitude as Europe. This fact is one which has remained important for the development of astronomical and cognate investigations at the Cape, right up to the present time. When Lacaille came to the Cape, a problem which was exercising the minds of scientists in Europe was that of the exact shape of the earth, and, although it was thought that the Northern Hemisphere was oblate, nothing was known about the Southern. In addition, the establishment of two observing stations in nearly the same longitude provided a long base line which could be used to determine the distance of the earth from the sun and afforded an opportunity for determining the apparent displacement of stars caused by the refraction of the atmosphere of the earth.

Lacaille set the tone for astronomical investigations from his own time up to the present by the prodigious work which he accomplished single-handed during his stay of two years at the Cape. He determined its geographical position quite accurately. He used a small transit instrument to determine the coordinates of nearly 10,000 stars. He delineated the southern constellations and gave them the names of "philosophical instruments"—the chemical furnace, the microscope, the telescope, and so forth—which they still bear today. He set out into the unexplored north, laid down and measured a geodetic base line, and triangulated it into a north-south line with astronomically determined end points, to determine the length of a degree of the meridian and so to discover whether the Southern Hemisphere of the earth had the same shape as the Northern. His conclusion that it did not, and that it was a part of a prolate spheroid, gave his successors much trouble, until it was discovered that the attraction of Table Mountain at the southern end of his line caused a deviation of the vertical. Finally, this one-man research institute measured the average distance of the earth from the sun by determining what is called "the solar parallax"; although his value was about 10 percent too high, making the sun appear nearer than it is in reality, to have obtained a result at all was a most remarkable feat.

Most of Lacaille's work must be regarded as preliminary in character, and requiring repetition, but his choice of problems was so sound that much of the

later work has been concerned with the same list of problems.

Falling as it did under Dutch jurisdiction, the Cape was left a prey to invasion during the Napoleonic Wars when the Netherlands were overrun. The region was temporarily occupied by the British, after which there was a withdrawal and, finally, a permanent occupation in 1814. The British, as the leading maritime nation of the world at that time, were keenly alive to the strategic and economic importance of the two ports on the Peninsula: Simon's Town, the naval headquarters on False Bay on the eastern side of the Peninsula, and Table Bay, the port of Cape Town on the Atlantic seaboard, at the northern end. Even at this late date navigational methods were not beyond reproach, and the positions of the southern stars were still not known with the necessary accuracy. In 1820, therefore, an Order in Council was issued which led to the establishment of the Royal Observatory at the Cape of Good Hope "for the improvement of astronomy and navigation." It was one thing to give orders, another to get them executed. The first incumbent of the office of His Majesty's Astronomer at the Cape was the Reverend Fearon Fallows, a mathematician from Cambridge, with but little practical astronomical experience. From the quiet of his English university town he was suddenly precipitated into a wild colonial life. Cape Town was still a very small town, and settlement in the hinterland amounted to no more than a few scattered villages and hamlets. Even so near Cape Town as the present site of the Royal Observatory, hippopotami and leopards were still to be found.



Cape Peninsula.

Fallows' first duty was to select an observatory site. To the east of Table Bay, but near enough to it to be visible from the decks of the ships anchored in the roadstead, there lay a little sandy hill, between two rivers, a desolate spot known as Slangkop, or Snake Hill. It was here that the observatory was finally erected, and here it still stands today, now in one of the inner suburbs of Cape Town. Fallows labored long and hard; finally he contracted scarlet fever and, in 1831, died of it.

His successor was Thomas Henderson, a man destined at first for the law, who became an amateur in astronomy and, finally, so much of an expert that he could be considered for the directorship of the Cape Observatory. Henderson was indeed a most remarkable man. He came to the Cape and remained only one year. He disliked the place intensely and found the desolate surroundings infinitely depressing. Forever after in his correspondence he would refer to the Cape Observatory as "Dismal Swamp," always with capital letters, and he was glad enough, in 1833, to return to Scotland, where he became the first of the Astronomers Royal for Scotland. He was on terms with his small staff which were none too good; he thought little of the quality of his instruments; and yet, in spite of the unreliability of these aids, Henderson, starting from scratch, was certainly the first man to measure the distance of one of the fixed stars, although, unfortunately, he did not publish the result soon enough to secure priority. At all events, he did not care for Africa (writing to Maclear in 1833 he said, "I will tell you about my residence in Dismal Swamp among slaves and savages—plenty of insidious venomous snakes. What would you think, if on putting out your candle to step into bed you were to find one lurking beside the bed?"), and his final resignation from the Cape was on a distinctly flimsy pretext.

It is at this point that Herschel and Maclear may be introduced, for both of

them arrived in the Cape early in 1834, Herschel as a private citizen undertaking an astronomical expedition, Maclear as the successor to Henderson in the post of His Majesty's Astronomer at the Cape.

John Herschel's Arrival

The two names have been described as obscure except to astronomers—an assessment which might be criticized, since those who know the name of Herschel are numerous enough. Unfortunately, the Herschel they know is not the Herschel of this story but his father, Frederick William Herschel, usually known as Sir William Herschel. He it was who began life as a bandsman in the Hanoverian Army, went to the fashionable spa of Bath in 1766 as a musician, took to astronomy first as an amateur and later as a professional, and became personal astronomer (Royal Astronomer, not Astronomer Royal) to George III.

It was William who was commemorated by Keats for his discovery of the planet Uranus ("Then felt I like some watcher of the skies when a new planet swims into his ken"), and it is William who is remembered by professional astronomers for his work on the development of reflecting telescopes, his studies of double stars, his determination of the spatial motion of the sun along the stars, and many other outstanding contributions. William began in obscurity and ended as one of the great celebrities of his age. Until the age of 50 he remained a bachelor, but, in 1788, he married a widow, Mary Pitt, and on 7 March 1792, their only child, John Frederick William Herschel, usually known as John Herschel, was born. Educated first at Eton and then by a private tutor, he went at the age of 17 to St. John's College, Cambridge.

John Herschel inherited his share of the family ability, and, in the distinguished environment into which his father had fought his way, he got off to a flying start. In 1813 he was senior wrangler, Fallows being third. He began his research career as a mathematician and wrote several memoirs. Then followed a brief period of legal study, after which the son, in collaboration with James South, reobserved the stars in his father's catalog of double stars. The Royal Society, the French Academy of Sciences, the Royal Astronomical Society, and other bodies showered honors upon him, and William IV knighted him. He repeated his father's survey of star clusters, using a 20-foot Herschellian "frontview" telescope—a form of reflector which has now become obsolete. Herschel had a good knowledge of chemistry and discovered the technique for fixing photographic images by means of "hypo." In 1826 he refused the chair of mathematics at Cambridge. In 1829 he married Margaret Brodie Stewart and eventually became the father of a large family. In other words, by the age of 40, John Herschel was a great celebrity, well endowed with this world's goods, a social lion, and a renowned scientific authority.

At some time in the early 1830's he made up his mind to undertake astronomical observations in the Southern Hemisphere, and it was this project which brought him to the Cape. Herschel's courage in undertaking a stay of four years at the Cape, and that of his wife in accompanying him with their family, should not be dismissed lightly. The voyage of 6000 miles was made in small sailing ships and took two or three months. It was in those days just about as tough a proposition to go to the Cape as it is in these days to go to the South Pole. This expedition was undertaken entirely at Herschel's own expense, and when, on his return, the British Government offered to reimburse him, he refused. While he was in South Africa, Herschel accomplished a tremendous work. In 1838 he returned to England, where Queen Victoria, at her accession, created him a baronet, and he was accorded a rapturous welcome. But strangely enough, after his return, Herschel never put eye to telescope again, and it was some years before he published his account of his work in a large volume, *Results of Astronomical Observations at the Cape of Good Hope.* Pritchard, in his biographical note on Herschel published in the *Encyclopaedia Britannica,* said, "Herschel had become an astronomer from a sense of duty, just as his father had become one by fascination and fixed resolve: hence it was by filial loyalty to his father's memory that he was now impelled to undertake the completion of that work which at Slough had been so grandly commenced. William Herschel had explored the northern heavens: John Herschel determined to explore the heavens of the south, as well as re-explore the north."

This judgment seems rather harsh. After all, many a man who has done much less than Herschel for the advancement of science is accorded ungrudging recognition. Yet, it is a justified assessment of Herschel, and all estimates of him must include this note of criticism. His was a complex character. He possessed ability of an outstanding order. He cannot be called a dilettante, for dilettantes do not best all comers in the mathematics tripos, nor do they undertake long and arduous research programs and bring them to successful conclusions. To have done, superbly, everything that he could do—in mathematics, astronomy, optics, chemistry, drawing, administration, social life—would have made Herschel a Leonardo or a Goethe, and such a man he was not. To sum up his character in a sentence, one might say that what he lacked was single-mindedness, and if he had had it, he might have been a genius.

Sir John Herschel.

As it was, the lack of need to fight as his father did dissipated his efforts, and his success at most things blinded him to the possibility of being outstanding at any one. From the beginning he had social graces and urbanity. In a hard-drinking age he was not reckoned anything but abstemious, but he could, on occasion, enjoy the pleasure of the table more than was wise. Never having been a professional, he lacked the tough-mindedness which carries the seasoned campaigner through moments of stress, and having been born with a silver spoon in his mouth, he did not encounter many such moments. Yet, in the end, he was a man of qualities, and the possession of these qualities turned out to be crucial for the years of his association with Maclear and provided the latter with the complement to his own personality necessary for his own success.

On 15 January 1834, the *Mount Stewart Elphinstone,* East Indiaman, put

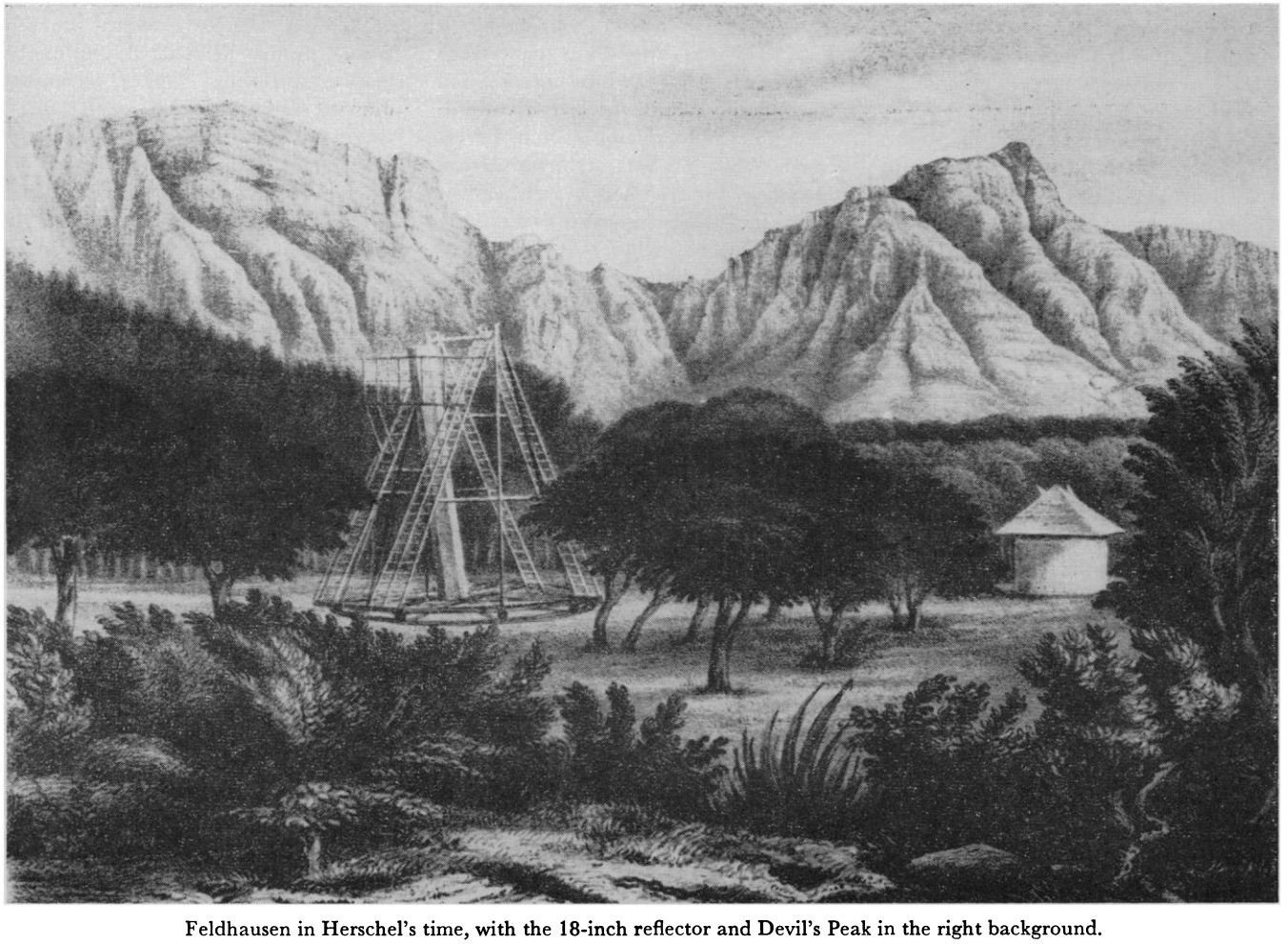
ashore her passengers at Table Bay, two months out from England. Among them were John Herschel and his wife and the four children—Caroline, Emilia Mary, William James, and Isabella—and the mechanic John Stone. In the baggage was a reflecting telescope of 20-foot focal length and a diameter of 1½ feet and what Herschel called, with a classicist's joke, three "sesquipedalian" speculum metal mirrors, to be used in it in turn. In addition he had an equatorially mounted refractor of 5-inch diameter and 7-foot focus. After a short stay in a private house, the Herschels moved to a farm called "Feldhausen," a Cape Dutch-style residence in extensive grounds just to the east of the Table Mountain massif, a property which Herschel purchased in the next year for the sum of £3000 (representing, probably, an amount not far short of $50,000 in terms of modern purchasing power). The estate (which was at that time sometimes also known as "the Grove") has been split up and encroached upon by building, but the house still remains, and the site of the reflector is now marked by a singularly ugly stone obelisk.

Astronomically speaking, the site is not particularly good. The annual rainfall in and around the Cape Peninsula varies enormously with situation relative to the mountains. Feldhausen probably has a rainfall (mainly winter rain) not far short of 50 inches per annum, whereas the Royal Observatory only four miles away, gets rather more than half of this. In addition, the western sky is cut off by the mountain wall, and this proved a handicap to Herschel in his observations of comets. However, at Feldhausen Herschel established himself for the four years of his stay. The 20-foot reflector was ready by 22 February, the equatorial by 1 May. In addition, he had a portable telescope which had been used by his famous aunt, Caroline Herschel, at Slough. A small cottage in the grounds became a workshop and polishing house for figuring the mirrors and a chemical laboratory for experiments, including some on the color of flowers.

Maclear's Arrival

The career of Thomas Maclear, up to the time of his arrival in Africa, could hardly have been in greater contrast. He was born in Ireland in 1794 and destined originally for the Anglican Church. Against this he rebelled, and, from the age of 15 years, he received a medical education under the supervision of two medical uncles, Sir George and Dr. T. Magrath. After completing his studies he became house surgeon at the Infirmary at Bedford, where he came in contact with the Smyth family, who were to exercise so strong an influence upon him. In 1823 he moved a few miles, to Biggleswade, where he practised in association with one of his uncles. In 1825 he married Mary Pearse, and in 1833 he was appointed His Majesty's Astronomer at the Cape, to succeed Henderson, whom he already knew well.

Obscure country doctors were not, even in the early 19th century, appointed to public positions without qualifications,



Feldhausen in Herschel's time, with the 18-inch reflector and Devil's Peak in the right background.

and the transition from medicine to astronomy requires some explanation.

The circumstances of the meeting between Maclear and the Smyth family, and their friend Dr. Lee, are a little obscure, but the period is that of Maclear's sojourn in Bedford, where the head of the Smyth family, most readily distinguished as Admiral Smyth, was then living. England has a reputation for nurturing and tolerating engaging eccentrics, and Admiral Smyth was certainly one such. His father was an American who sided with the British at the time of Independence. Smyth himself served in the British merchant navy, and then in the Royal Navy during the Napoleonic Wars. He held command in the Anglo-Sicilian fleet at Messina and, finding himself there, made hydrographic surveys of the area on his own initiative, a proceeding of which his superiors fortunately approved. In 1815 he married the daughter of an English merchant in Naples, and he also met the Italian astronomer Piazzi. From that time onwards, Smyth devoted himself to astronomy as an amateur, and when his second son was born, he named him Charles Piazzi Smyth—a name which we must keep in mind, for Charles Piazzi Smyth was eventually to become assistant to Maclear at the Cape. Astronomy did not absorb all the energies of the admiral, and he produced a large illustrated work on old coins and medals. This too is of importance, for the antiquarian interests of the father were probably the starting-point for Charles Piazzi Smyth's obsession with the Pyramids of Egypt—the son was, indeed, the originator in later life of all the Pyramid cults, some of which still flourish.

Admiral Smyth, returning from the wars, settled down to a period of retirement at Bedford and devoted himself to astronomy as a hobby. He became prominent in the affairs of the Royal Astronomical Society and, about this time, became an intimate friend of Dr. Lee, a wealthy lawyer, who was also an amateur astronomer. Lee eventually bought Smyth's instruments and set them up at Aylesbury, yet another of the small towns in the more distant outskirts of London.

Astronomy bit these well-to-do amateurs as Hi-Fi might bite them today. Smyth produced a quite good two-volume description of astronomical objects in the northern sky, under the titles of *The Bedford Catalogue* and *A Cycle of Celestial Objects,* interlarding the astronomy with some very odd stuff in-

Mr. (afterwards Sir) Thomas Maclear. [By permission of Her Majesty's Astronomer at the Cape]

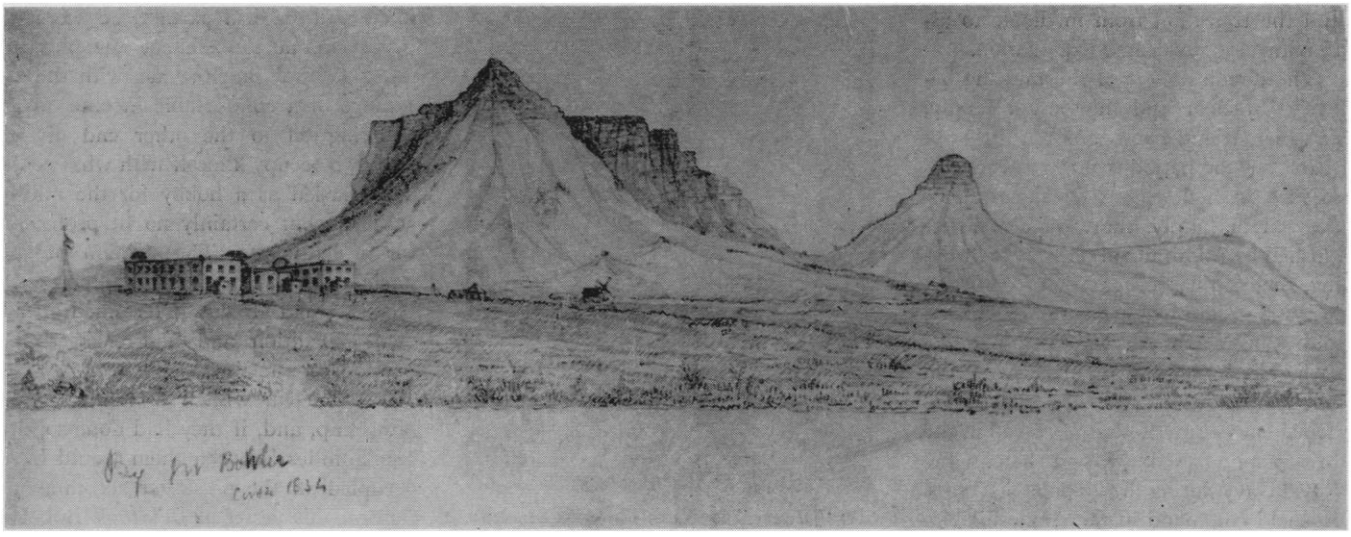
deed. As one reviewer put it, "The descriptions of the various objects are enlivened with a vast amount of general classic and antiquarian lore, introduced in a most genial spirit." Smyth and Lee could afford the time for these activities, but it remains a mystery how Maclear could earn his living as a doctor (and command the affection of his patients—they got up a subscription and presented him with a piece of plate when he went to Africa) and still find time for all his astronomical activities. He observed eclipses, the phenomena of Jupiter's satellites, and so forth, just as any amateur may do today, but he also ran a transit circle and determined star positions and, in cooperation with Smyth and Lee, made extensive geodetic traverses. He became a member of the Royal Astronomical Society and found time to run up to London to attend meetings, at which, no doubt, he first made the acquaintance of such men as Herschel and Henderson. Eventually, when the post at the Cape fell vacant, Maclear was an amateur of sufficient distinction to be considered for it. It must, however, be acknowledged that there was, in all probability, little competition. The remoteness of Africa and its uncivilized condition were two of the discouraging factors. Moreover, the history of the Observatory itself cannot, at that date, have seemed very rosy. In 12 years there had been two directors, and, if rumor was to be believed, not only were some of the instruments far from reliable but there were difficult staff questions to be resolved as well.

In the eyes of his contemporaries and, more especially, in the eyes of Maclear's uncle and medical partner, he was mad to go—insane to exchange the pleasant quiet of rural Biggleswade, with the assurance of a comfortable income, to go traipsing off to the other end of the world to occupy himself with what could be regarded as a hobby for the mildly eccentric but certainly no fit profession for a gentleman. The opinion of the uncle was of very practical importance. Herschel had already determined on his own expedition and had engaged his passage on the *Mount Stewart Elphinstone*. Maclear wished to travel on the same ship, and, if they had done so, the two families between them would have occupied all the passenger accommodation on this vessel of 611 tons. But, for Maclear, his wife, five children, and two servants, plus the governess, Mary Geard (whom they forgot in getting their first estimates), the passage money would be £350. This was big money, and, as Maclear did not possess such a sum, he turned to his uncle and partner, only to meet with a brusque refusal to supply a single farthing.

In the meanwhile, Admiral Beaufort, Hydrographer to the Navy, was busy on their behalf and, in September 1833, wrote that he had a passage for Maclear in a government ship for £36. An interesting sidelight on travel conditions of the time is thrown by Beaufort's letter to Maclear, which urges him to "come up on Monday to see your cabins and order your pigs and chickens and potted meats" and recommends that he take a store of well-dried potatoes and apples as antiscorbutics. Finally, the whole party embarked at 8 in the morning of 10 October 1833 on the *Tam O'Shanter*; in spite of the good report on the captain given by a friend, whom, with naive prudence, they had had inspect the master mariner as he drank in a tavern, they were all hideously seasick, and one of the children died.

The Assistants

Their relief as they stood on the deck of the *Tam O'Shanter* on the morning of 5 January 1834 and looked at Table Mountain must have been immense. Maclear must have been only too sensible of the fact that new problems awaited him, and even more concerned by the discovery that his so-called "free passage" to South Africa was going to cost him, according to some strange contemporary formula, the staggering sum of £220.



Bowler's drawing of the Royal Observatory, 1834, with Devil's Peak in the left background. [By permission of Her Majesty's Astronomer at the Cape]

What the passengers thought at that moment is not entirely a matter of conjecture, for one of them, a manservant of Maclear's, has come down to us as a minor historical character, possibly better known in South Africa than Maclear himself. This was one Thomas Bowler, who was recommended to him by the wealthy Dr. Lee. Bowler was the grandson of one of Lee's housekeepers; evidently he had several houses and several ladies to keep them, for in a letter of 7 December 1833, John Hawkins, brother-in-law of Mrs. Maclear, who was looking after the Maclear interests in England, wrote, "Dr. Lee has taken to wife a lady who until that time fitted the important situation of Housekeeper . . . I have not heard more particulars but conclude it is not the grandmamma of your servant nor is it the one who lives at Colworth."

Bowler's connection with the life he had lived in England made Maclear at first regard him as a stable and reliable element in an uncertain world. Maclear had need of trustworthy colleagues, for, when he arrived at the Observatory, he was met by Henderson's assistant, Lieutenant Meadows. Under Henderson, Meadows had worked well as an observer, but, by the time Maclear had arrived, he was a soured and dissolute individual maintaining a *ménage à trois,* who greeted his new chief with what must have been one of the coolest welcomes on record, "So, Sir, you have determined to accept this wretched appointment." From this auspicious beginning they never looked back, and it was not long before the lieutenant and his entourage were on their way to England.

Thus Maclear was more or less forced to rely on Bowler and would send him down to Simon's Town to draw Observatory funds, or to carry out other responsible tasks, and after some time Bowler was given the vacant post of "Labourer" and even contributed a little to astronomical observation. The honeymoon did not last, and Bowler's behavior became wonderfully awkward. At first he lodged in the East Wing of the Observatory and, by contemporary standards, could have been fairly comfortable. When Maclear dismissed him he felt so much responsibility for him that he wrote a full account of the affair, both to Dr. Lee and to the clerk at Simon's Town, one Mr. Deas Thompson. The Labourer, said Maclear, might "boil his own kettle morning and evening, and cook his own steak. He can be as comfortable at the Observatory as anywhere. The butcher and the baker come every second day." Bowler got £70 a year, the usual salary for a clerk. Boarding-houses at the Cape charged high, and a careful fellow could board for himself. "A 10 lb fish is 2d or 3d, butcher's meat 1½d to 2d per lb. Bread, vegetables and butter as dear or dearer as in England. Bowler is steady and if he can acquire an obliging disposition to his employer he will do well." This Bowler could not do, and, although Maclear boarded him free out of his own pocket for a time, Bowler insisted on taking his meals in the village of Rondebosch and was, in consequence, absent for two hours or more three times a day. Eventually he insulted Mrs. Maclear in some way, and Maclear turned him out. He kept himself by instructing the daughters of neighboring farmers in that mysterious polite accomplishment—one wonders how often it was made use of—"the use of the globes." Already, while at the Observatory, Bowler had begun to draw, and his first sketch was one of the Observatory and its surroundings in 1834. Bowler went on to become a professional artist, and modern knowledge of the contemporary buildings of Cape Town and, indeed, of life in most parts of the Cape, owes much to numerous drawings and prints which Bowler afterwards produced. Although inconsiderable as an artist, Bowler was important, and almost alone, as a recorder, and his work now fetches a considerable price.

The tale of Maclear's assistants is completed by mention of the arrival, in 1835, of Charles Piazzi Smyth, son of the old admiral, who came as a boy of 16. He, at least, was biddable, hard-working, competent, and enthusiastic and no mean astronomical artist. He remained with Maclear for many years, eventually leaving to become Astronomer Royal for Scotland. His later distinction in spectroscopy and in his attempts to observe the solar corona in daylight from the summit of the Peak of Teneriffe, as well as his eccentric preoccupations with the Pyramids of Egypt and their capacity for the prediction of the destinies of the human race, belong to another story.

These were only some of the difficulties which Maclear had to overcome, and the fact that he did overcome them and made of the Royal Observatory the considerable institution which Sir David Gill was later to raise to eminence, is a

measure of the toughness of his character and of his devotion to duty. That Maclear was tough, there is no doubt; had he been less severe and less determined he would have failed. In later years his staff recognized both his inflexibility and the need for it and, among themselves, would refer to him as "the Emperor," while, on Maclear's retirement in 1870, his virtues were so widely recognized and he was so well-loved a figure that the Colonial Legislature passed a special resolution to mark the occasion, and he was accorded the same kind of rapturous public welcome that Herschel had received on his return to England from South Africa.

Yet another personal difficulty faced Maclear on his arrival at the Cape. Here he was, in an isolated community where medical care was, no doubt, primitive even by the elementary standards of the early 19th century, a qualified doctor professionally employed in a completely different field. Maclear himself recognized the difficulties which might face him. In his diary for 1834, on 5 February, he wrote, "I am afraid of dipping into Physic," but, to a large extent, he did manage to stick to the new last, to the total exclusion of the old. He treated himself, dosed the Meadows family, drew a tooth for Lady Herschel, and amused himself on one occasion by dissecting a snake which had been killed in the Observatory grounds. Perhaps his zoological interests were somewhat wider and better known than this single incident would indicate, for stray characters would occasionally appear with snakes in varying degrees of liveliness which they hoped to sell to Maclear.

There are few better examples of Maclear's devotion to duty, of the horrors of old-style medical treatment, and of the relations between Maclear and Herschel than the following incident, which begins with the entry in Maclear's diary for 10 April 1834. Maclear writes:

> Remarked a peculiar sensation in my mouth on the right side—the feeling of a crumb of bread or something in it. When I blew my nose the cheek filled out and became inflated, while the left preserved the usual muscular resistance so that to do this effectually I am obliged to push in my cheek with my hand. There is no loss of sensation. . . .
>
> 10 o'clock. Took a dose of Epsom salts. On exam^{g} my face in the glass I find that on laughing the integuments are drawn to the left side and in masticating food the space on the right side between the gums and cheek is filled but I cannot without the pressure of my hand empty it. I cannot effectually close my right eye. For some days I have been working hard with the mural circle. My left eye became tired and painful & 2 days since was rather inflamed, with a pain shooting into my head.

Then follows a blow-by-blow account of his struggle with his facial paralysis, which lasted until the end of the month. The regime of purging, cupping, blistering, and application of leeches which he adopted seemed to be based on the idea that the illness would give up in disgust if assaulted in every conceivable way. Sir John was distressed and sent him a consolatory letter in his customary style. Herschel's ideas of consolation ring oddly in modern ears, but friendship survived even this. He wrote:

> I am sorry to find your bulletin speak of no improvement but '*courage mon ami*'—if the worst comes to the worst, a twisted visage may be put up with. In the case of a bachelor on his preferment, it might be a serious thing, but once family taken 'for better for worse' and estimated and loved for qualities more than skin deep a man may keep the laugh on his side though it may be only on *one* side,
>
> Adieu.

Herschel and Maclear

Much of our knowledge of the personal relations between Herschel and Maclear depends on the extensive correspondence, usually Herschel's side only, which is preserved in the South African archives. Herschel's epistolatory style was so remarkable that one is tempted to linger over it far too long. He often wrote the most excellent sense, but in doing it he equally often behaved like a ham actor. He gestured, he underlined, he exclaimed, he made little academic jokes, and he dragged in quotations in all the numerous languages he knew. He indulged in florid turns of speech, he condescended amiably. When he was excited—which was often—his handwriting was atrocious, and he abbreviated his words to such an extent that it is sometimes almost impossible to make out his meaning. Here, for instance, is a brief note which he wrote to Maclear on an occasion when he was engaged—actually with the assistance of Bowler—in making tidal observations in Table Bay.

> Thursday Afternoon
>
> My dear Sir,
>
> I have made so dreadful a *mess* of the Tide Ob^{sn} I took on *Monday* as well as of the Meteorological Ob^{svg}, by using Daniel's watch —as defies all my power to decipher—i.e. in respect of time. It is something so compounded of the ludicrous & the melancholy as to be an epitome of the great tragi-comedy of human life. In truth I am ashamed to shew it to you—yet as a matter of curiosity and philosophical enquiry it may be worth while. I shall therefore ride over to the Observatory between the High and Low water tomorrow and "make a clean bosom" of the whole affair.
>
> Tomorrow (Friday) the stroke of 8 will find me on the jetty. If you will be up, I think I shall take the Observatory in my way and pick up a time I can depend on. My blunders (if blunders they were—i.e. if the evil one had not his finger in the pye) went to whole hours —half hours and quarters. It is something enormous—incredible—and to me utterly incomprehensible,
>
> Yours in haste,
>
> J. F. W. Herschel.
>
> P.S. On second thoughts I will not come via the Observatory. There will be too little time and I shall miss the Observations altogether most likely by so doing.

A laconic note in pencil is added to this letter in Maclear's handwriting, "A fog. Missed his way and found himself at Tyger B. T.M." Tigerberg is about five miles away from the Observatory in the wrong direction.

It is surprising that the mutual affection of the two men survived some of the assistance which Herschel was ready to render. Their relations always remained warm, but the nature of the relationship changed. When Maclear first arrived he was almost overwhelmed by immediate obstacles, and the moral and practical support of Herschel undoubtedly sustained him. As Maclear's self-confidence grew, it was he who became the more active and professionally tough-minded of the two. Herschel tended to retreat to the side lines and to offer advice, some of it good, some impractical.

For example, in 1837 Maclear set to work to measure a geodetic base line on low-lying ground near the Observatory. This was done by laying rods supported by trestles end to end and measuring the gaps between. Herschel certainly helped a great deal with the preparatory work, and the first attempts began in March. On 12 March Herschel felt constrained to write from Feldhausen:

> My dear Sir,
>
> I feel so thoroughly the need of a day's rest after the Met Obsn^{s} that I must beg you to excuse my not keeping my app^{m} tomorrow (Thursday) but will . . . come on Saturday (the other being Good Friday)—yesterday's work was too much for me the Therm the whole day being at & above 90 and being exposed for some hours out of doors has produced a degree of over excitement which makes me fear another fit of sinkings something of which I now begin to feel.
>
> I send specimens of lines engraved on mica with a steel needle—Glass does not satisfy me as it is so difficult to get a *scratch* which will not be a *cut* nor turn up at the edge—I think mica will do . . . not having the dimensions I have drawn the lines at random,
>
> Yours truly,
>
> JFWH

The mica scales were for measuring the interval between the measuring rods, and were no doubt of real assistance. For all his verbosity, Herschel was quite willing and capable of tendering excellent advice, some of it based on the most lengthy and precise cogitation. The

"Met Obsns" referred to are another matter in which Herschel seems to have been an innovator. In addition to ordinary daily observations taken at one or two fixed times in the day, he proposed that on four days in the year observations should be taken throughout the 24 hours, and this he proceeded to do unaided. The records which he made every hour from the morning of 20 December 1835 until the evening of 22 December have been preserved, having been copied out by Piazzi Smyth for presentation to Dr. Lee's observatory at Hartwell. Lee made a note on the copy to this effect, and, by a coincidence, the document has now found its way back to the South African Library in Cape Town.

To revert to the measurement of the geodetic base line: By June of 1837 work was well under way, and present with Maclear were Sir John, Lieutenant Williams of the Sappers, and Piazzi Smyth. After one day, Herschel had a cold but came to visit. During the operations the wind blew over one of the rods, and the work was then held up until November because the low-lying ground became flooded. Herschel's idea of consolation ran:

> My dear Sir,
> I am sorry for the accident but I confess I was at no time sanguine as to the completion of the base without some interruption of the kind. The rods are top heavy and in case of any new operations commenced here with such instruments I should urge on the attention of those concerned a thing which if you recollect I did at one time mention as no imprudent precaution. . . .

(Then he goes into details of a plan for adding kingposts, braces, and stabilizing weights to the rods and, after signing himself, adds, "P.S. The first 700 feet of the Irish base were obliged to be remeasured by an accident similar to yours.") Herschel never confined himself to one letter if two could be written, and the following undated note must refer to the same incident:

> I feel today so great an increase of certain very unpleasant sensations which were creeping over me the whole of yesterday, that I hold it very doubtful whether I shall be in a condition to come over tomorrow or at all events for more than an hour or two in the warm part of the day—indeed I begin to perceive that another entire day's duty in your swamp will go nigh to lay me up for the winter, and I cannot help feeling that there are many days' work before that measurement will be completed—to say nothing of some unlucky jog which may render it necessary to remeasure the whole.

One of the accompanying illustrations, which is reproduced from an old print, shows that Herschel's ideas for the measurement of a geodetic base line were adopted by Maclear. The print shows Maclear laying out a standard base line on the Grand Parade in Cape Town where it might be used by surveyors for checking their tapes and chains; in the background can be seen the measuring rods, complete with the kingposts and braces lying on their supporting trestles.

Making Surveys

This may be a convenient point at which to summarize the general program of survey work undertaken by Maclear. It begins at the point, already mentioned, where Lacaille had concluded that the Southern Hemisphere of the earth was a prolate and not an oblate hemisphere. Between Lacaille and Maclear, Everest, of the Survey of India (he after whom the mountain is named), had spent some time at the Cape trying to pick up Lacaille's survey points to check his work, and one of Maclear's most important assignments was to do this again, and more thoroughly, and to extend the work. Maclear spent much time in his first years at the Cape exploring the town and its surroundings, identifying the site of Lacaille's observatory and trying to recover his stations. In this he was not completely successful, for the trail was 80 years old, but he did find a certain number of the points used by Lacaille, even, in some cases, finding the ashes of the signal fires which his predecessors had used. After this preliminary work Maclear, assisted by voluminous correspondence and discussion with Herschel, began to examine methods which he might adopt in his work. (In this International Geophysical Year it is interesting to look back and to see how the pair anticipated some of the most up-to-date geodetical methods, which are now practicable because of improved equipment.)

The connection of surveys across sea barriers is still a major difficulty today. Maclear and Herschel were not concerned with sea barriers, but they had in mind the possibility that they might have to carry a survey across inaccessible country.

They therefore experimented with rockets fired at Muizenberg, observing them from the Observatory and from Simon's Town, the object being to connect the two places without having to survey the intervening ground in detail. Much the same idea was behind the observations of lunar eclipses from Feldhausen and the Observatory. The observations consisted in timing, as exactly as possible, the moments when the eclipse shadow arrived at particular craters on the moon, and they hoped that they might be able, from their observations, to determine the relative positions of their two observing stations with great accuracy. That Herschel and Maclear failed was due to no error of principle; when they found their methods insufficiently accurate, they turned to more conventional ones.

In chronological order, Maclear's work in surveying and geodesy may be summarized as follows: First came the historical investigation, with the object of repeating what Lacaille had done; then came discussion of methods with Herschel. Serious work had to wait until Maclear was provided with assistance by the arrival of Piazzi Smyth, in 1835. Toward the end of 1836 Maclear first measured a base line on the Grand Parade in Cape Town, a little while after he had first commenced survey operations near the Observatory. The abortive base line was spoiled by floods, and improvement of the measuring rods came in 1837. The Parade base line, having been, presumably, inadequately marked, was remeasured on 2 December 1837. The base line near the Observatory had already been completed a few weeks before, by means of the improved measuring rods.

Herschel, not to be outdone, had meanwhile measured a little base near Feldhausen and surveyed in some of the surrounding landmarks. An almost indecipherable letter, written in the dark on 3 December 1837, expresses his relief at having missed the work on the Parade:

> Your expedition in matters of business puts to shame my tardiness & proves to me that I am getting hardly fit to inhabit a bustling world like this. While I speculated on how long is to take to get the guns—how long to get them sunk—how long to take up and sink again in consequence of detected errors—and how long to get all in order—behold your Parade base is measured—as it is I am rejoiced that I have *escaped* being present. That *broil* would have *done* me thoroughly. The next thing I expect to hear of is Messrs Maclear, Smith Williams & Co—ill of brain fevers. . . .

From this point on, Maclear moved into the field of scientific geodesy. He was not able certainly to recover Lacaille's marks, and in the end embarked on what became, first, an independent local survey, leading many decades later, long after his time, to the establishment of the official government Trigonometrical Survey Office of South Africa.

For his scientific work Maclear obtained the use of a historic instrument, the zenith sector which had been employed in his researches by Bradley, the

discoverer of the aberration of light. The idea was suggested by Airy, the Astronomer Royal, and in 1837 this monstrous instrument was shipped out and reassembled. Monstrous is the only possible descriptive adjective, for, when set up for use, this contraption required a tent 17 feet high to house it and protect it from the wind. Year after year, Maclear, Smyth, and others lugged this piece of equipment and its wigwam over uncharted and roadless country for hundreds of miles, up to the tops of mountains and across rivers and ravines. Most of the duplication of Lacaille's work was completed before the departure of Herschel, in March 1838; during this time they went as far as the Piketberg region, about 100 miles north of Cape Town. In the years immediately following, they reached as far north as the mouth of the Orange River, still a scantily populated and remote district, where one of the mountains is named—no doubt mysteriously in the eyes of the present inhabitants—the Sector Berg. Maclear later gave an account of these proceedings, omitting the racy correspondence of Herschel, in an official Observatory publication, *The Verification of Lacaille's Arc of the Meridian,* published in 1867.

Cataloging the Southern Sky

The principal object of Herschel's journey was to discover and catalog the nebulae and double stars of the southern sky. This was done by the method of sweeping devised by his father. It consisted in setting the telescope at a particular declination and making notes of the objects which appeared in the field as the sky was carried past by the rotation of the earth. Objects of special interest could then be given detailed observation later. Eccentric though Herschel's character was, it would be grossly unfair to him not to emphasize that he carried out this program very efficiently and that, even to this day, there are many cases where his observations remain the only ones. Herschel has left his record in the *Observations at the Cape of Good Hope, 1834–38,* which has already been mentioned. His catalog of nebulae is probably superior to his catalog of double stars, for the latter contains many examples of wide, optical (as distinct from physically related) pairs. His catalog of nebulae comprises not only what we would now call extragalactic ("spiral") nebulae, which are genuine large-scale independent systems resembling the Milky Way system in size and constitution, but also all the details of our own Milky Way system which he observed, conspicuous only because of their

The measurement of the geodetic base line on the Grand Parade, Cape Town, 1837.

proximity to us. These details included (in modern nomenclature) galactic clusters, diffuse nebulae, and planetary nebulae. The drawings which Herschel made of some of the more prominent of these in many cases bear excellent testimony to his powers of observation, now that they can be compared with modern photographs. There are, of course, some surprises. Some of the easily observed objects are misrepresented, but, equally remarkable, some of the most difficult are faithfully represented.

One of Herschel's requirements for this work was the knowledge of the positions of stars which he could use as reference points for the determination of the positions of his newly discovered objects. A considerable proportion of the correspondence between Herschel and Maclear at this time consists of requests from Herschel for the determination, by means of the transit circle or mural circle of the Observatory, of the right ascension and declination of reference stars.

This requirement introduces two themes into the correspondence. One was the errors of the catalog produced by Dunlop at the observatory of Sir Thomas Brisbane at Paramatta, New South Wales. The references are confusing, but the names "Dunlop Catalogue," "Brisbane Catalogue," and others all seem to refer to the same compilation of positions of southern stars. Both men found themselves very critical of Dunlop's work, which they decided was full of systematic and casual errors, causing them a great deal of trouble. Typical of Herschel's remarks are these:

> There are a few (i.e. *not* a *very* few) cases of 12 or 13 sec discord^{n} in these *probably* an error of 10^{s} has been committed on one or other part in the detail of reduction. Where I have examined them your work appears correct. Some cases of 20^{s} and upwards also occur—In the bad cases I have verified my own bringing up of the stars from D's Catal. . . .

and

> On the whole I am sorry to observe that this shewing is even more unfavourable to the Brisbane Catal. than the results of any of my previous comparisons—with other authorities —The errors follow no traceable law. Henceforth I feel disposed to dismiss the epithet the *Brisbane* Catal as connected with this remarkable astronomical record, & rather to designate it by the names of those concerned in its composition— it is worthy of the age of Ulugh Beg or Tycho Brahe. . . .

The award to Dunlop of the Lalande Medal for astronomy by the French Government provokes the remark: "I wish the awarders would come here and look for some of his nebulae and double stars."

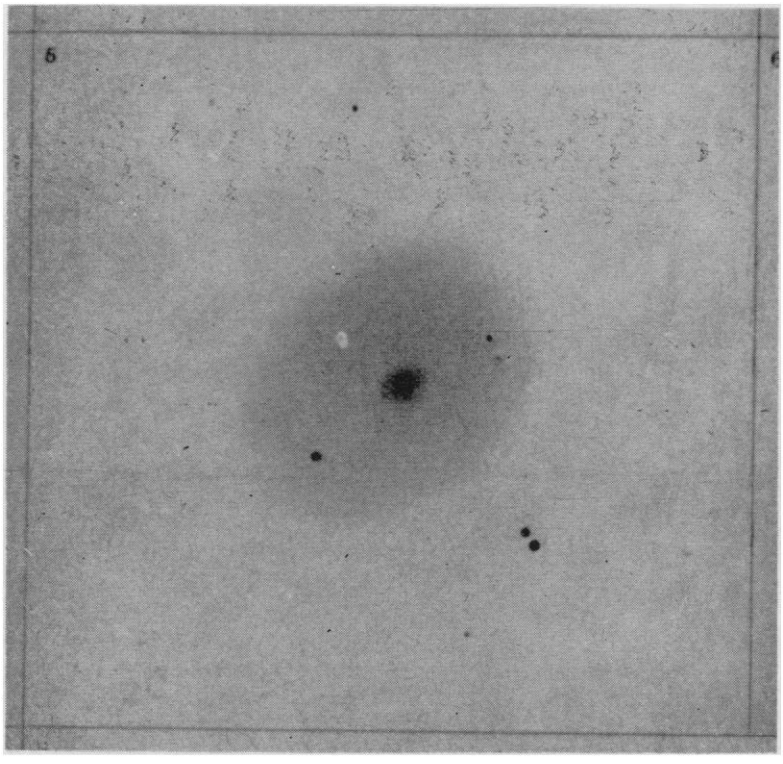
All this is, of course, no more than the customary small change in the expression of mutual esteem between scientific colleagues, but, unfortunately, these two had been rather outspoken in their criticism, and at the end of 1837 Sir George Gibbs, the new Governor of New South Wales, appeared at Cape Town en route to take up his post. He entered the lists in support of the Australians, and Maclear had to eat humble pie, blaming the errors on the fact that the reductions of Dunlop's observations had been carried out in England. This piece of buck-passing did the trick, and peace was restored.

The second topic which united Herschel and Maclear in adversity was the mural circle of the Observatory. One of the principal instruments originally provided was this 6-foot mural circle. This, now obsolete, type of instrument consisted of a telescope pivoted on a horizontal axis, the axis itself being mounted as accurately as possible in an east-west direction by being fixed in a substantial wall running north and south. Thus, the instrument always pointed in the meridian, and the declination of a star observed with its aid could be determined from the inclination of the tube when the star passed through the center of the field. If the time of passage of a star was observed, then, if the right ascension of the star was known, the sidereal time could be measured, and the error of the sidereal clock could be found; or, if the error of the sidereal clock was known, the right ascension of a star could be found by determining the clock time of the transit of the star through the field. In these respects a mural circle closely resembled a transit circle, but, because the mounting of the former was fixed, there was not the possibility of eliminating instrumental errors, as can be done with a transit circle by reversing it in its bearings from time to time.

When the mural circle was being unloaded, in 1826, it was damaged by a fall, and thereafter it never functioned satisfactorily. Fallows had found troublesome errors in the measures obtained with the instrument, and he, Sheepshanks, Airy, and Henderson had all written papers on its behavior before Maclear arrived.

Even today it is never assumed that the art of the instrument maker is so perfect that his products are free from error. Elaborate methods have been devised for making explicit determinations of errors. Herschel seems to have discovered independently many of the modern methods still in use, and his letters include elaborate mathematical discussions of the effects of instrumental errors.

The principal difficulty was the multiplicity of the different kinds of possible error: lack of circularity of the "circle," ellipticity of its pivots, and errors in the graduations were three of them. In their



Herschel's drawing of the nebula NGC5236.

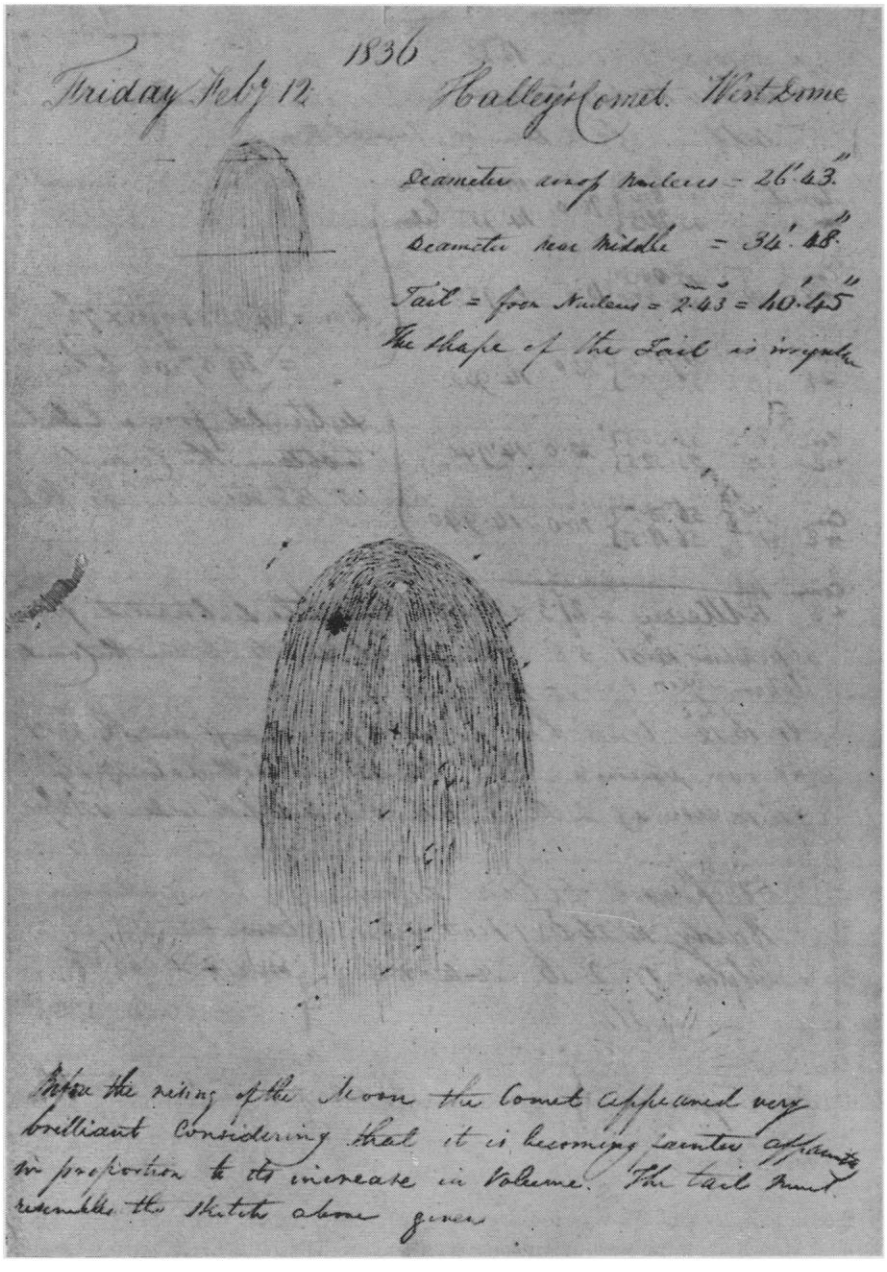
A modern photograph of the nebula NGC5236 (image reversed as compared with Herschel's drawing). [By permission of Her Majesty's Astronomer at the Cape]

efforts to disentangle these, Herschel proposed the use of *Fühlhebeln,* or levers of contact, which would register deviations of form much as the modern dial gauge does; he also proposed to observe the movements of a dot placed on the end of the axis as the instrument was turned. To determine the circle errors he thought of mounting two microscopes on the circle at an interval of ten degrees, and, since the circle and the telescope could be clamped and unclamped and moved relative to each other, to stride round the circle with this "ten degree" interval until a complete circuit had been made; the closure error would then give the true value of the "ten degree" interval, and the graduation errors could be inferred.

The story of the mural circle ends in complete anticlimax. The instrument was never satisfactory and was finally returned to England and stripped for renovation. It was then found that one of the supporting collars was loose on the axis. In view of the fact that nearly a dozen elaborate mathematical discussions of this instrument had been published, there is probably a useful moral to be drawn.

Halley's Comet

One of the great astronomical events to be expected during Herschel's stay was the return of Halley's comet, which was expected to pass through perihelion on 7 November 1835, in the southern sky. Both Herschel and Maclear observed it assiduously, and they originally intended to produce a joint publication containing their results. In the event, this did not come to pass, and Maclear produced an independent publication in the *Memoirs of the Royal Astronomical Society* for 1838, profusely illustrated by drawings made by Piazzi Smyth. The correspondence is confused by the fact that, in their letters, the writers always referred to "the Comet," whereas in fact there were two comets—Halley's comet and Encke's comet, the latter being seen in September. Halley's comet had already been seen in Europe before perihelion and had aroused great excitement. In the south it was eagerly awaited, but there was trouble with the weather, moonlight, and the obstruction of Herschel's western horizon by mountains (which he could not remove) and by trees (which he did). In an undated fragment Herschel wrote, "Somebody told me today the comet had been seen in Cape Town—with Naked Eye—this evening has been so uniformly cloudy as not to give a chance—This is very provoking—as the situation *now* is getting favourable and it ought to have a tail or at least to show a pretty considerable nucleus. But there is a vile moon in the way." Then Maclear found the comet,



Maclear's drawing of Halley's Comet, February 1836 (from his observing notebook). [By permission of Her Majesty's Astronomer at the Cape]

and turned to Herschel to make sure he had not confused it with a nebula. "I think I may give you the joy of being the first Rediscoverer of Halley's Comet. I find no known nebulae in the places you describe." Herschel was particularly put out by the fact that his mechanic, John Stone, and his son James casually happened to mention that they had seen Halley's comet over Table Mountain one evening with the naked eye and had forgotten to tell him.

On 19 November 1835, there was a total solar eclipse, and Herschel was much excited over the possibilities: "By the way, in this eclipse, which is a *total* one in some parts—the *Comet* will be seen—in or near its perihelion!! Seneca witnessed such a phenomenon in the year AD 60—what a pity the line of total shadow is wasted in the desert of S. Africa and Guinea, But in Madagascar and the Indian Seas it will surely be observed & we shall no doubt hear of it. . . ." This expectation does not seem to have been borne out, but they continued to observe and discuss Halley's comet until March or April of the next year.

Another unprecedented event which Herschel was, this time, privileged to witness was the Nova outburst of the star Eta Argus (Eta Carinae); the nebulosity round this star forms the subject of one of his most detailed plates in his *Observations at the Cape of Good Hope*. This star had been a relatively inconspicuous "naked-eye" object until it flared up in December 1837; after the outbreak it declined until it is now below naked eye visibility, although still somewhat variable in brightness. Understandably all agog with his discovery, Herschel wrote to Maclear at 10:30 at night on 16 December: "I beg to call your attention to η Argus as a most remarkable variable star. Tonight it is superior to α Eridani and not much if at all inferior to Rigel. . . ." He continues with a rehearsal of his previous observations of the brightness of the star, and resumes: "Tonight it is ridiculous to class η with such stars as Fomalhaut or even with Procyon. He laughs α Crucis to scorn.

"Query how big *will* he grow? It has come on very suddenly. Tonight he caught my eye as *a great star unknown* and I was obliged to shift my place of ob^{s} to get the cross in sight before I could be sure it was η.—I have noticed him several times this season at his usual lustre (i.e. not presenting anything remarkable) and it is not above a week or 10 days since I was saying to Stone—'There's η Argus getting high—we must soon begin upon him again'. . . ." At its brightest, η Argus was the fourth brightest star in the sky, but its decline was rapid.

In quoting all these magnitudes Herschel used a method developed by his father. This is the method of sequences, still in use in a modified form, where the magnitude of a variable star or other unknown object is estimated with reference to a sequence of known stars whose brightnesses straddle that of the unknown one.

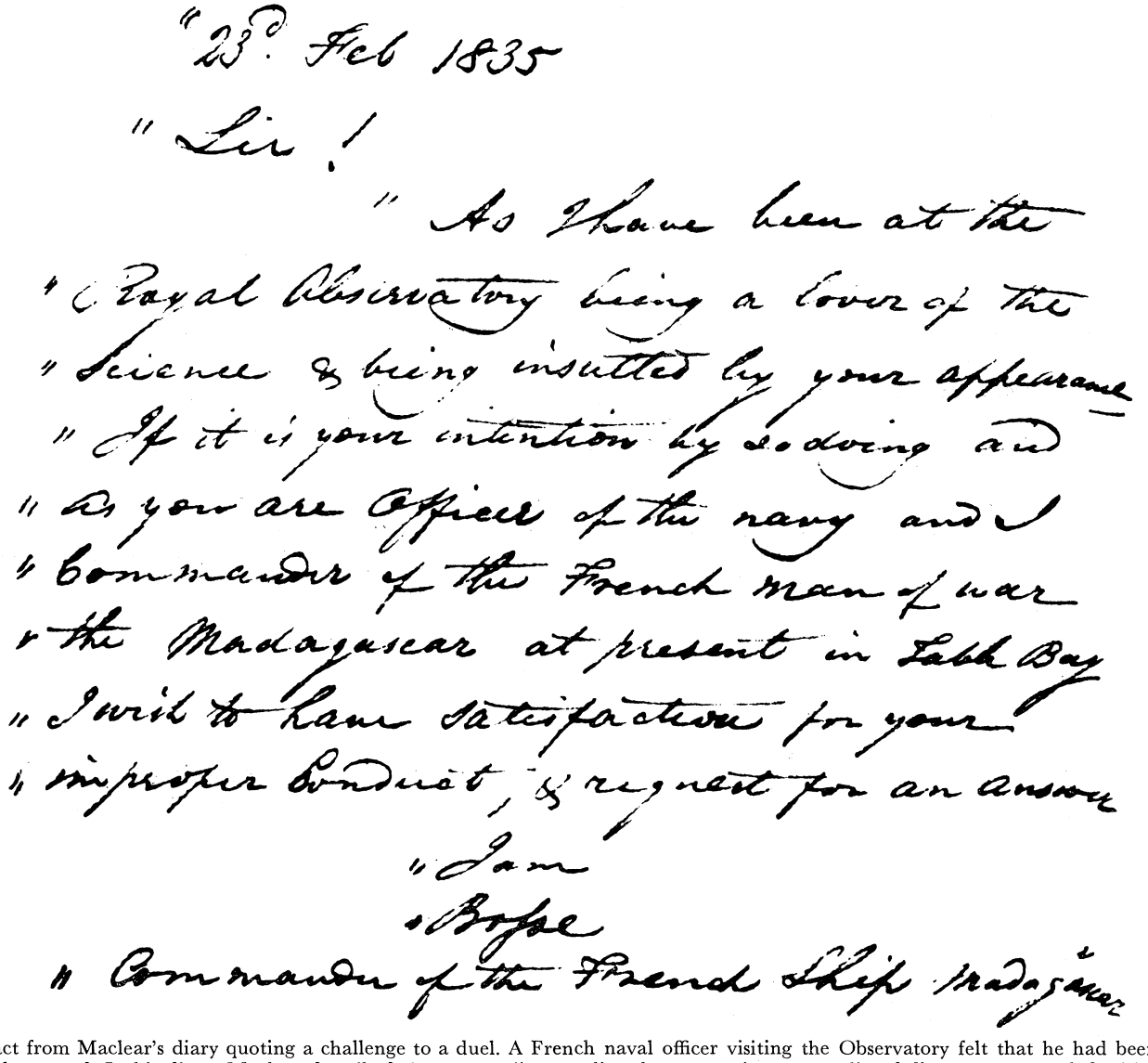
The "Astrometer"

During his stay in South Africa, Herschel developed what seems to have been the first reliable method of actually measuring the magnitudes of stars, an exercise to which he was prompted by the gross and obvious errors in the statements about star magnitudes on the existing charts of the southern sky. This device he called the "astrometer," and the accuracy attainable with it was not to be despised, for some of his results were not bettered until almost as late as the beginning of the photoelectric era. Herschel used a total reflection prism and a lens to form a reduced image of the full moon, the equipment being mounted on a string-operated slide so that the reduced image could be moved

to different distances from the eye of the observer, its apparent brightness thus being made to vary. No telescope was used, and the observer simply held up the device so that he could see both the star to be measured and the little lunar image. He then slid the optical unit to such a distance that the star and the lunar image appeared equally bright, after which he measured the distance from his eye to the artificial star and used the inverse square law to derive a magnitude for the actual star. This simple device is typical of the genius which Herschel had for neat improvisation, and it is regrettable that his use of it seems to have been rather limited.

The flavor of the Herschel correspondence makes it clear that he was well versed in the classics and in the antiquarian lore of the constellations. Naturally, too, from his researches both in the North and the South, Herschel was familiar with all the constellation names then current, and he formed the opinion that reform of the nomenclature and boundaries was long overdue. In his day the northern constellations were much as we know them now, and the principal southern constellations were, and are, as they were named by Lacaille. Herschel embodied his plan for constellation reform in several letters to Maclear. Briefly, he wished to have every constellation of moderate extent bounded by a convex polygon, and to have either star-free vertices or vertices marked by stars. All names were to be different—and not names of individuals but of classes of persons, such as Rex, Heros, Poeta, and so on. All stars brighter than the fourth magnitude were to have individual names, and groups of stars were to be named after "well recognised classical assemblages" such as Pleiades, Muses, Graces, or Nymphs. Another idea was that the initial letter of the name of the constellation should correspond roughly, through its alphabetical position, with the right ascension of the constellation, and (to quote) "that all attempts to accommodate the attitudes or outlines of Figures to the stars of constellations . . . be given up as useless & hopeless labour and that maps with figures on them be regarded as children's toys."

Maclear quite liked the proposition but felt that it would not be accepted, for Herschel displayed the eccentricity of wanting to keep Orion as a constellation but with the figure reversed. That reform was desirable can be seen from some of Herschel's lists: there were Hydra, Hydrus, and Hydra Femella (now obsolete) as well as Serpens and Draco; a Musca in both the North and South, and Apis and Apus adjacent to each other, as well as many other dupli-


"23d. Feb 1835

"Sir!

"As I have been at the
"Royal Observatory being a lover of the
"Science & being insulted by your appearance
"If it is your intention by so doing and
"as you are Officer of the navy and I
"Commander of the French man of war
"the Madagascar at present in Table Bay
"I wish to have satisfaction for your
"improper Conduct, & request for an answer

"I am
"Sir
"Commander of the French Ship Madagascar

Extract from Maclear's diary quoting a challenge to a duel. A French naval officer visiting the Observatory felt that he had been impolitely treated. In his diary, Maclear described the note as ". . . a literal copy—written on a slip of dirty paper & sealed with a bit of wax with the impression of the thumb!" The duel was not fought. [By permission of Her Majesty's Astronomer at the Cape]

cations and possibilities of confusion. It is regrettable that Herschel conceived his plan in his own exuberant and slightly eccentric fashion and that he does not seem to have pressed the matter further.

Observing the Tides

Two other interests of the pair were meteorology and tidal observations. For Maclear these subjects formed part of his official instructions. For Herschel they were opportunities to exercise his somewhat wayward genius. In addition to the routine work, Herschel invented an instrument called the actinometer, which consisted of a thermometer with a large bulb filled with a dark-colored liquid. This was placed in the sun and the shade alternately, and the rate of rise of the liquid surface gave an opportunity of making rough measurements of the incident intensity of the solar radiation. Both men served on the local meteorological committee, and the correspondence is full of reiterated requests that Herschel's barometer be compared with that at the Observatory. Some of this concern was connected with the desire to ascertain the difference in height between the Observatory and Feldhausen. Herschel also devised the plan, already mentioned, for taking hourly observations throughout periods of 24 hours or more at the equinoxes and solstices. He went on to make experiments on the use of solar radiation for cooking and other purposes and records that a meal of mutton stew and potatoes was prepared in his solar cooker. His best systematic study was the detection of an annual fluctuation, and a daily fluctuation the magnitude of which varied with the seasons, in the barometric height.

The investigation of the tides was another subject which fell within the scope of Maclear's official instructions, and Maclear began the installation of a tide gauge in Table Bay in 1835. Thereafter this topic took an increasingly large share of his attention, for he took an interest not only in the tides in Table Bay but in those in Simon's Bay as well, and the apparatus employed became steadily more complicated. In the early days, Herschel, "assisted" by Bowler, would take the readings himself. Later on, a man who rejoiced in the profession of "tidewaiter" was employed, and Herschel devoted much time and thought to the problem of devising an apparatus to ring a bell when the tide was at midwater (either rising or falling) so that the tidewaiter might "take his cloak, lanthorn, key and pencil and go to the gage . . ." to take the readings. These tidal observations at the Cape were part of a widespread scheme, of which the moving spirit was Whewell, the Cambridge mathematician, for taking tidal observations at the same time all round the coasts of Europe and at other places where opportunity offered. Herschel and Maclear were anxious to secure a self-registering gauge, but this did not arrive until 1840, when it was installed first at Simon's Bay, where it remained for 20 years (a complete revolution of the moon's nodes), and later at Table Bay.

Herschel occupied himself to a great extent in the statistical and harmonic analysis of the results, demonstrating the presence of the terms due to change in the lunar and solar declinations, but the subject soon became a routine one, and Herschel turned to more varied fields.

Finally, in 1838, Herschel packed up his instruments, sold his house, and returned to England. It had been a lively time in South Africa, with many new interests and stimulating problems. For Herschel there was a dignified and unproductive middle age, full of honor and respect. For Maclear there was the memory of four years of moral support and intellectual stimulation, and, for him, there were many years more of productive scientific work. The memory of their time together remained with them both. Maclear, having ceded his pension to his wife, was financially embarrassed when she died before he did, and Herschel intervened in official quarters to adjust matters. Herschel died before Maclear, who wrote the former's obituary notice, and even then, though aged and beset with blindness, there came back to him warm memories of all that they had done together (*1*).

Note

1. Use has been made in the preparation of this article of the Maclear papers in the South African Archives, particularly the file of letters written to Maclear by Herschel. In addition, the following unpublished documents in the possession of the Royal Observatory at the Cape have been consulted: manuscript diary of Maclear and observing notebook of Maclear (both about 1835); correspondence referring to Bowler; fragments of the diary of Thomas Henderson. I am much indebted to my wife for assistance in the transcription of many of these documents.

What Kind of Science Teaching Program?

To interest high school and college students in science, begin when they are elementary school students.

Lactitia Bolton

Herbert Hoover's indictment of the American high-school system as "one of the major causes" of our failure to produce enough scientists and engineers is typical of one kind of widespread public reaction to Sputnik's assault on our national self-esteem. Scientific authorities and politicians have been telling us that we should not have been surprised by this revelation of the Russians' superiority in space science. In an atmosphere ringing with echoes of "We told you so," it is hard for any of us to escape a conviction that we have made a massive, collective blunder, and it is natural for us to cast reproach on the people we hold responsible for it. First on the list are the educators, who are now hard put to answer the accusing question, "Why aren't we producing more scientists?"

Before making a scapegoat of education we should recognize that, by and large, it is an instrument of national policy rather than a prime mover. Teachers who have been struggling to carry out the national mandate to educate all our children for a democratic way of life should not be held too strictly to account for a program dictated primarily by school boards, which are more or less

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