

A CHERRY TREE TO MARS^{*}

by

Carl Sagan

Laboratory for Planetary Studies

Cornell University

Ithaca, New York

It is a lazy afternoon in an exquisite New England autumn. In about 10 weeks it will be January 1, 1900 and your diary, into which are committed the events and ideas of your young life, will never again bear an entry with a date in the 1800's. You have just turned 17. You are looking forward to being a sophomore in high school, but you are now at home, in part because your mother is seriously ill with tuberculosis and in part because of your own chronic stomach pains. You are bright, with a certain flair for the sciences, but no one has ever indicated that you might have an extraordinary talent. You are complacently viewing the New England countryside from the limb of a tall

* Based on an address at a symposium commemorating the 50th anniversary of the first liquid-fuel rocket flight, launched by Robert H. Goddard, held at the Smithsonian Institution, Washington, D.C., March 16, 1976.

old cherry tree which you have climbed, when suddenly you are struck by an idea, an overpowering and compelling vision that it might be possible, in fact rather than in fancy, to voyage to the planet Mars.

When you descend from the cherry tree you know that you are a very different boy from the one who climbed it. Your life's work is clearly set out for you and for the next 45 years your dedication never wavers. You have been smitten by the vision of flight to the planets. You are deeply moved and quietly awed by the vision in the cherry tree. The next year, on the anniversary of that vision, you climb the tree again to savor the joy and meaning of the experience; and forever after you make a point in your diary of calling the anniversary of that experience "Anniversary Day" -- every October 19th until your death in the middle 1940s, by which time your theoretical insights and practical innovations have solved essentially all technological impediments to interplanetary flight.

Four years after your death a WAC Corporal mounted on the nose of a V-2 is successfully fired to an altitude of 250 miles, for all practical purposes to the threshold of space. All essential design elements of the WAC Corporal and the V-2, and the very concept of the multiple staging of rockets have been worked out by you. A quarter of a century later, unmanned space vehicles will have been launched to all the planets known to ancient man; a dozen men will have set foot on the moon; and two exquisitely miniaturized

spacecraft named Viking will be on their way to Mars to attempt the first search for life on that planet.

Robert H. Goddard never questioned or equivocated on the resolve he made in the cherry tree on the farm of his Great Aunt Czarina, in Worcester, Massachusetts. While there were others who had comparable visions -- notably Constantin Eduardovich Tsiolkovsky in Russia -- Goddard represented a unique combination of visionary dedication and a remarkable technological brilliance. He studied physics because he needed physics to get to Mars. He was for many years professor of physics and chairman of the physics department at Clark University in his home town of Worcester.

In reading the notebooks of Robert Goddard, I am struck with how powerful his exploratory and scientific motivations were, and how influential speculative ideas -- even erroneous ones -- can be on the shaping of the future. In the few years surrounding the turn of the century, Goddard's interests were profoundly influenced by the idea of life on other worlds. He was intrigued by the claims of E. C. Pickering, the Director of the Harvard College Observatory, that the moon has a perceptible atmosphere, active volcanism, variable frost patches, and even changing dark markings which Pickering interpreted variously as the growth of vegetation or even the migration of enormous insects across the floor of the crater Eratosthenes. Goddard was captivated by the science fiction of H. G. Wells and Garrett P. Serviss, particularly the latter's "Edison's

Conquest of Mars" which, Goddard reported, "gripped my imagination tremendously." He attended and enjoyed lectures by Percival Lowell, who was an eloquent advocate of the proposition that intelligent beings inhabit the planet Mars. And yet, through all of this, while his imagination was intensely stimulated, Goddard managed to keep a sense of skepticism very rare in young people given to interplanetary epiphanies high up in cherry trees: ". . . The actual conditions may be entirely different . . . from those which Professor Pickering suggests . . . The only antidote for fallacies is -- in a word -- to take nothing for granted."

On January 2, 1902, we know from Goddard's notebook, he wrote an essay on "The Habitability of Other Worlds." Unfortunately, the paper has not been found among Goddard's writings, which is a great pity. It might give us a much deeper understanding of the extent to which the search for extraterrestrial life was a prime motive in Goddard's life-work.

In his early post-doctoral years Goddard pursued successfully an experimental verification of his ideas on solid and liquid fueled rocket flight. In this endeavor he was supported principally by two men: Charles Greeley Abbott and George Ellery Hale. Abbott was then a young scientist at the Smithsonian Institution of which he later became Secretary, the quaint designation by which the executive officer of that organization is still known. Hale was the driving force behind American observational astronomy at the time; before

he died, Hale had founded the Yerkes, Mount Wilson and Mount Palomar Observatories -- each housing, in their time, the largest telescope in the world. Both Abbott and Hale were solar physicists and it seems quite clear that both had been captured by the young Goddard's vision of a rocket sailing free above the obscuring blanket of the Earth's atmosphere, able to view the sun and stars unimpeded. But Goddard soared far beyond this daring vision. He talked and wrote of experiments on the composition and circulation of the upper atmosphere of the Earth, of performing gamma ray and ultraviolet observations of the sun and stars from above the Earth's atmosphere. He conceived of a space vehicle passing 1000 miles above the surface of Mars -- by curious historical accident just the low point in the orbits of the Mariner 9 and Viking spacecraft. Goddard calculated that a reasonably-sized telescope at such a vantage point would be able to photograph features tens of meters across on the surface of the red planet, which is the resolution of the Viking orbiter cameras. He conceived of slow interstellar flight at velocities and time scales just equivalent to that of the Pioneer 10 and 11 spacecraft, our first interstellar emissaries.

Goddard's spirit soared higher still. He conceived, not casually but quite seriously, of solar-powered spacecraft and, in a time when any practical application of nuclear energy was publicly ridiculed, nuclear propulsion for spacecraft over vast interstellar distances. Goddard imagined

a time in the far distant future when the sun will grow cold and the solar system become uninhabitable for our remote descendants, when manned interstellar spacecraft would be outfitted to visit the stars -- not merely the nearby stars, but also remote star clusters in the Milky Way Galaxy. He could not imagine relativistic spaceflight and so hypothesized a method of suspended animation of the human crew or -- even more imaginative -- a means of sending the genetic material of human beings which would automatically, at some very distant time, be allowed to recombine and produce a new generation of people. "With each expedition," he wrote, "there should be taken all the knowledge, literature, art (in a condensed form), and description of tools, appliances, and processes, in as condensed, light, and indestructible a form as possible, so that the new civilization could begin where the old ended." These final speculations, entitled "The Last Migration," were sealed in an envelope with instructions to be read "only by an optimist." And that he surely was -- not in the sense of a Pollyanna who chooses to ignore the problems and evils of our times, but in the sense of someone committed to the improvement of the human condition and the creation of a vast prospect for the future of our species.

Goddard's dedication to Mars was never far from his mind. In the wake of one of his first experimental successes, he was induced to write a press release on the details of his launch, and its ultimate significance. He wished to discuss spacecraft to Mars, but was dissuaded on the grounds that

this was too fantastic. As a compromise he talked about sending a quantity of magnesium flash powder which would make a visible bright flare on the moon when it landed. This caused a sensation in the press. Goddard was, for many years later, referred to as "the Moon Man," and he remained rueful about his relations with the press ever after. (An editorial in the New York Times which criticized Goddard for having "forgotten" that a rocket will not work in the vacuum of space may have contributed to his unease. The Times retracted its error only in the age of Apollo.)

Goddard mused "From that day, the whole thing was summed up, in the public mind, in the words 'moon rocket;' and thus it happened that in trying to minimize the sensational side, I had really made more of a stir than if I had discussed transportation to Mars, which would probably have been considered as ridiculous by the press representative and doubtless never mentioned."

Goddard's notebooks are not filled with psychological insights. That was not, at least very much, the spirit of of the times in which he lived.* But there is a remark in

* Although, remarkably, he was in Worcester, Massachusetts, in the year 1909 when Sigmund Freud and Carl Gustav Jung gave the first comprehensive discussion in the English language of those institutionalized insights called psychoanalysis. Many American psychiatrists cut their teeth on the subject from Freud's Clark University lectures. One wonders if the middle-aged bearded Viennese physician and the young mustachioed American physics graduate student nodded to each other in passing on the Clark University campus, on their way to their separate destinies.

Goddard's notebooks which can only be a flash of poignant self-insight: "God pity," he wrote, "a one-dream man." For that surely is what Goddard was. He knew great satisfaction in seeing the advances in rocket technology, but it must have been agonizingly slow. There are so many letters from Abbott urging faster progress, and so many responses from Goddard citing practical impediments. Goddard never lived to see the beginning of rocket astronomy and high altitude meteorology, much less flights to the moon or planets.

And so, I would like to make a proposal. October 19, 1976 will be the 77th Anniversary Day of the martian vision of Robert H. Goddard. On that day, if all goes well, there will be two functioning orbiters and two working landers on Mars, the Viking spacecraft whose origin can be traced with utter confidence back to a boy in a cherry tree in a New England autumn in 1899. Among its many other objectives Viking will be checking out the possibility of life on Mars, the prospect which was so powerful a motivation for Goddard so many years ago. I propose a modest celebration, if all goes well with Viking, at the Viking control facility of the Jet Propulsion Laboratory in Pasadena, California. For of all the fruits of Goddard's genius, Viking would, I think, have been closest to his heart.