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techniques can be developed to make these components survivable under a direct cost-affordable enemy ASAT attack (where a highly concentrated ground- or space-based offensive ASAT system need attack only a small part of a BMD system that is necessarily thinned out by the constraints of satellite motion). But then the very same techniques would also make it possible to have survivable space-based offensive nuclear warheads, which could be rapidly decelerated and launched at ground targets by mass transfers from satellites moving in the opposite direction, for example; they would give considerably less warning time and be much harder to defend against than ICBMs. Such warheads are at present banned by the 1967 Outer Space Treaty, but an abrogation of the 1972 ABM Treaty will surely undermine the 1967 treaty as well.

The fear of direct offensive space weapons was repeatedly expressed by Mikhail Gorbachev during the recent summit meeting in Geneva, where he also warned that all arms-control constraints will be "blown to the winds" unless Star Wars is stopped. The Soviet Union may well respond to SDI deployment by deploying a space-based nuclear-warhead system, masquerading, perhaps, as a defensive x-ray-laser BMD system (along with decoy satellites). If it feels threatened enough, it may respond even with a nonsurvivable system, which could still be used in a "preemptive" first strike. If so, "our last state will indeed be worse than our first" (Matthew 12:45).

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12/85

Absolute dating

Regrettably, though perhaps predictably,¹ the exchange between Robert V. Gentry and me on absolute dating and polonium halos (December 1984, page 91) has not clarified the argument as I intended. His rejoinder, flawed and evasive, is too misleading to stand unanswered. Therefore, since I do not wish to give the impression by default that he has won the day, I will attempt to clear up some of the confusion he has engendered.

Gentry does not, in fact, disprove the annual nature of layered sequences, such as certain tree rings and Greenland ice cores, which indicate ages greater than 6000 years. His failure even to mention the ice-core data, a common creationist practice,² betrays his professed objectivity. This evasion is especially disingenuous because the

Greenland ice cores are new to this forum and almost certainly the best long-term absolute dating scale.

Contrary to Gentry, I did not claim that bristlecone pines produced no multiple, or false annual, rings. What I meant, following H. C. Fritts,³ was that in their natural habitat they are not as susceptible to false rings as other species are known to be.

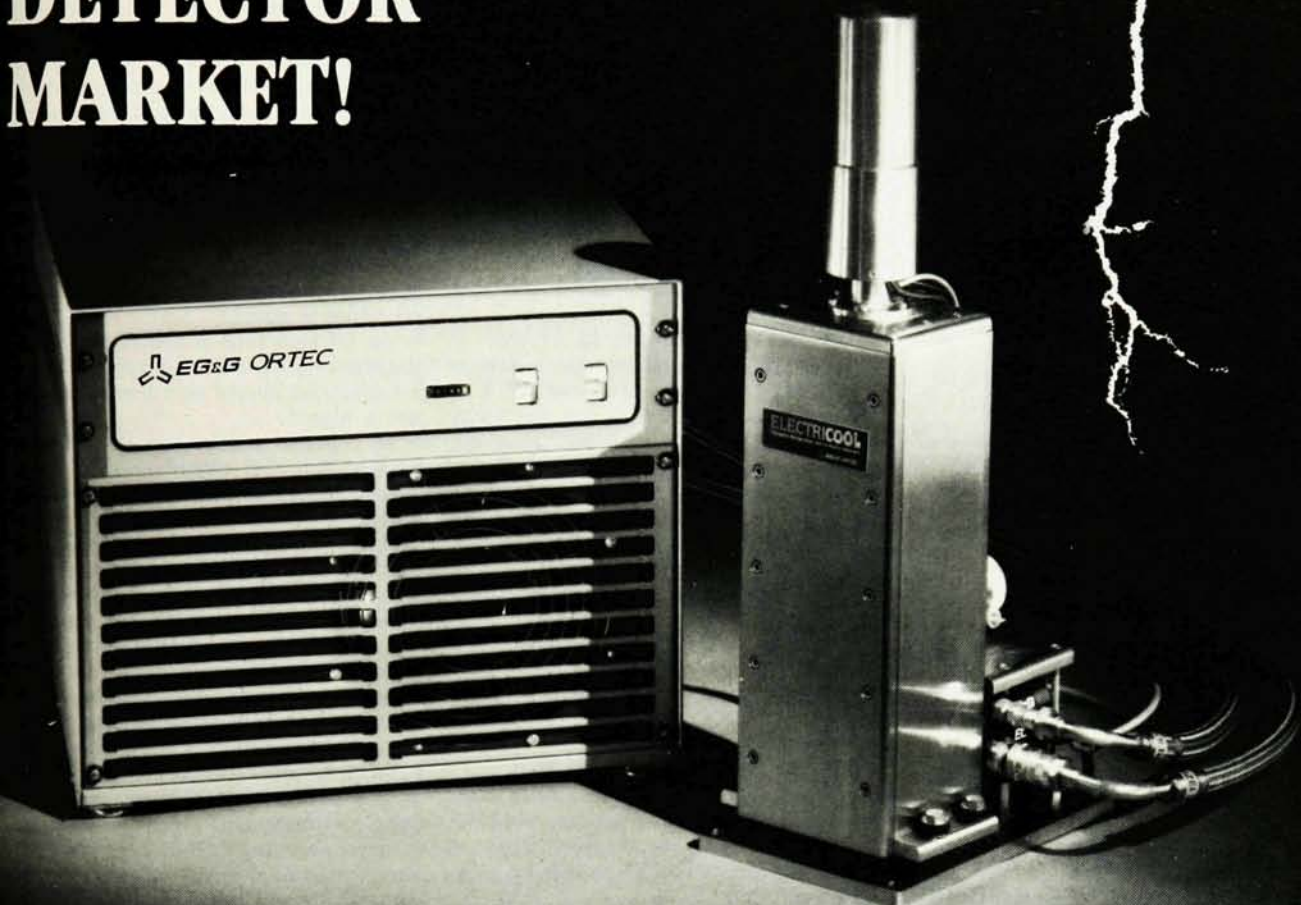
Gentry's reference to W. E. Lammerts,⁴ then, is not only misguided, but irrelevant. Lammerts produced false rings in bristlecone seedlings by manipulating growing conditions, but he ignores the fact that false rings can be detected by microanalytical and x-ray techniques⁵ in addition to visual inspection, which he considers unreliable. Regardless that false rings can be identified reliably, creationists need up to one-third of the rings to be false so that all the rings fit into the period since the Flood.⁶ Gentry's attempt to disprove the age of the bristlecone pines fails because false rings in mature trees are extremely rare, and especially so at the sites studied.⁷

What must surely qualify as the "coercive evidence" Gentry would accept as validation for the extreme age and annual nature of bristlecone-pine and ice-core records is at hand. Just as trees ingest carbon-14, the ice caps capture beryllium-10 from the atmosphere. Because the production of both isotopes is a function of solar activity, the variation of C^{14} and Be^{10} over time in trees and ice, respectively, should parallel each other closely if they preserve true annual strata. Such a comparison is possible now that mass spectrometry is sensitive enough to measure⁸ the small amounts of Be^{10} in the melted ice. Because C^{14} would be used only as a marker and not for dating, I hope Gentry will agree that this test would certify the validity of the bristlecone-pine chronology.

Two other significant items bear on Gentry's case. First, while granites are Precambrian, they are *not* primordial, as Gentry seems to think. The oldest rocks on Earth are not granites.⁹ However polonium halos were formed, they did not witness any beginning. Second, the Green River Formation of shale and limestone, covering tens of thousands of square miles, contains 20 million varves of paired light and dark layers. Creationists ascribe their formation to turbidity currents during the Flood. This would mean three layers laid down every two seconds, which is highly unlikely. More credibly, this formation is witness to 20 million years of sedimentation,¹⁰ which severely undermines the validity of the creationists' 6000-year time scale.

Finally, in my December letter I did not intend for Gentry to be insulted, but merely wished to indicate his falli-

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bility by recalling his role in an earlier episode involving radiohalos. I apologize if my remarks exceeded this objective.

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2/85

Stellar companions

I would like to make a few comments on David Helfand's report (April, page 19) "Stellar companion appears to be giant planet":

► The basic theory of the structure and evolution of stars of very low mass (M below $0.1 M_{\odot}$) that is applicable to brown dwarfs and black dwarfs was presented in two papers that I published¹ in 1963.

► As I discussed in 1963 and in subsequent² papers, the end product of the evolution of a star of very low mass is a completely degenerate object of zero luminosity. I referred to such an object as a (low-mass) black dwarf in my papers. Before reaching the black-dwarf stage, the star goes through a self-luminous phase for approximately one billion years, and the terminology "brown dwarf" is appropriate for this pre-black-dwarf phase in the evolution of such a star. During the self-luminous phase the star is sufficiently hot at its surface to be detectable by optical, infrared and radio telescopes.

► Whether we are talking about the self-luminous phase or the final, nonluminous state, it should be kept in mind that brown dwarfs and black dwarfs are quite different from giant planets in the solar system. The masses of the brown and black dwarfs lie in the range $0.07-0.01 M_{\odot}$, or $70-10 M_{J}$, where M_{J} is the mass of Jupiter (24). (The

upper limit of this range gives the approximate value of the minimum mass on the hydrogen-burning main sequence, as discussed in my 1963 papers.) On the other hand, the masses of the planets in the solar system, including the giant planets, do not exceed $0.001 M_{\odot}$, or $1 M_{J}$. Not only are the masses of these degenerate stars much greater than those of giant planets, but the basic processes of star formation also appear to be different from those of planet formation. Stars are generally formed by instabilities in interstellar gas-dust clouds, while planets are formed by collisional-accretion processes in the material surrounding a star.³

► As far as VB8B is concerned, from the observational data⁴ it appears to be a degenerate star of very low mass and not a planet.

► In a paper published² in 1972, I pointed out the significance of low-mass degenerate stars (brown dwarfs and black dwarfs) for the missing-mass problem. I tentatively concluded in that paper that luminous and nonluminous stars of very low mass contribute significantly to the total mass in the galactic disk and the rest of the galaxy. I am happy to note that this suggestion is now being looked at⁵ seriously by some astronomers. Since 1962, I have argued for the existence of a large number of brown and black dwarfs in the real universe, and I am delighted with the recent announcement concerning VB8B. However, I am not too happy with the statement that VB8B and other, similar objects are planets beyond the solar system.

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4/85

Physics and the military

Charles Schwartz preaches clear thinking, sensibility and logic in his reply to Jocelyn Tomkin (May, page 15). He claims that they should lead the US scientists and engineers to "withdraw from the nuclear arms race," which he sees as one of the first steps to disarmament. Employing the same three above-mentioned principles, I would