provide an explanation of the regularity of slip bands observed in aluminum by Heidenreich and Shockley.[4] In the course of a single revolution of one arm of the spiral, the spiral becomes tangent to the potential slip plane or planes which may operate with use of the Burgers vector associated with the spiral. A given slip plane occupies this tangent position at least twice in one revolution. Regions of tangency of this type satisfy in an almost ideal manner the conditions required for multiplication. It is true that the length of the spiral which lies in the slip plane is small if the spiral is smooth. On the other hand, the spiral becomes elongated in the direction of the Burgers vector by a slip mechanism when a shearing stress which has a component in this direction is present. Opposite ends of the spiral move in opposite directions. Since vacancies become redistributed during this motion as a result of local heating and the expansion and interaction of portions which lie in the slip planes, there appears to be little to inhibit multiplication in the neighborhood of the tangent planes. There are $2n$ tangent planes spaced a distance d apart if the double spiral possesses n revolutions in total, and if the spacing between neighboring arms is d.

Multiplication need not be restricted to the tangent planes if the shearing stress field becomes sufficiently large; however, simple considerations show that there is much less interference in these planes during early stages of plastic flow so that they possess a natural preference. Considerations of this type also suggest that thermal agitation will greatly aid in the multiplication process. It would be very interesting to know if slip bands are formed as readily in metals deformed plastically at very low temperatures as in those deformed at room temperature or above. Multiplication is by no means[5] necessary for plastic flow if there are as many as 10^{12} dislocations rings in a unit volume.

[1] F. Seitz, Phys. Rev. 79, 890 (1950).
[2] The notation employed here is essentially that of W. T. Read and W. Shockley, Phys. Rev. 78, 275 (1950).
[3] F. C. Frank and W. T. Read, Phys. Rev. 79, 722 (1950).
[4] R. D. Heidenreich and W. Shockley, "Report of Bristol Conference on The Strength of Solids" (Phys. Soc. London, 1948).
[5] See for example the discussion by the writer in "Report of Pittsburgh Symposium on Plastic Deformation in Crystalline Solids" (Naval Research Laboratory, 1950).

The 2.7μ-Bands of Carbon Dioxide

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THE $\nu_1+\nu_3$ and $2\nu_2^0+\nu_3$ bands of carbon dioxide have not been well measured because they lie in the region of the 2.7μ-water vapor band. By the use of the vacuum grating instrument we have been able to record the carbon dioxide bands with no interference from water vapor. A cell of 28 cm length with 10.5 cm of Hg pressure was used in the measurements. A boat of phosphorus pentoxide in the cell removed any trace of water vapor left in the gas sample. The bands were well resolved with a slit width of 0.6 cm^{-1} by a 7500 lines-per-inch replica echelette grating.

The low frequency side of the $2\nu_2^0+\nu_3$ band was disturbed by what is believed to be a $C^{13}O_2^{16}$ band. The center of this isotope band has not been located.

By use of combination relations applied to the rotational lines, we have obtained the following results:

Band	ν cm^{-1}	$B'' = B_{000}$ cm^{-1}	$B' - B''$ cm^{-1}
$\nu_1+\nu_3$	3715.70	0.3893	-0.0031
$2\nu_2^0+\nu_3$	3613.68	0.3896	-0.0028

The value of B_{000} is in good agreement with other measurements. The values of ν are in good agreement with the values calculated by Adel and Dennison, as adjusted by Herzberg.[1]

[1] G. Herzberg, Infrared and Raman Spectra (D. Van Nostrand and Company, Inc., New York, 1945), page 274.

Cross-over Transitions in Ir^{194}, Ag^{110}, Cs^{134}

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ACCORDING to the accepted decay schemes[1-3] for these isotopes, cross-over transitions might be expected. A search has been made for these transitions using the photo-disintegration of beryllium and deuterium as threshold detectors for high energy γ-radiation. The photo-neutrons were detected by a Szilard-Chalmers reaction in ethyl iodide[4] under conditions in which the detection efficiency had been measured as a function of energy.[5]

Approximate estimates of the intensities have been made, using pile activation data to give the disintegration rate of the isotope; the accuracy of these is about 50 percent. The results are shown in Table I.

TABLE I. Cross-over transition data.

Isotope	Ir^{194}		Ag^{110}		Cs^{134}
Expected energy (Mev)	1.7	>2.2	2.21 or 1.8	2.3 or 2.9	1.96
Expected intensity (photons/ disintegration)	3×10^{-6} or 10^{-3}	nil	—	—	10^{-5}
Observed intensity (photons/ disintegration)	1.4×10^{-3}	2×10^{-6}	3×10^{-4}	$<10^{-4}$	$<10^{-4}$

Ir^{194}—The 0.3 Mev and the 1.4 Mev γ-rays are assumed to be electric quadrupole in cascade; the expected intensities are calculated for the two alternatives of the 1.4 Mev or the 0.3 Mev γ-ray being emitted first. The assumption is made that the cross-over is 16 pole. The results suggest that the 0.3 Mev γ-ray is emitted first. The γ-ray which disintegrates deuterium does not fit the decay scheme; the intensity is 100 times too great to be attributed to bremsstrahlung from the high energy β-ray.

Cs^{134}—The upper limit to the intensity is in good agreement with the results of Fluharty,[6] which had escaped notice until the experiment had been completed.

Ag^{110}—The spectrum is very complex and the only definite conclusion is that an "intermediate" cross-over occurs with measurable intensity.

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[5] R. W. Parsons (private communication).
[6] R. G. Fluharty and M. Deutsch, Phys. Rev. 76, 182 (1949).

On Time-Independent Integrals of Motion of the One-Body Problem in Dirac Theory

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THE purpose of this note is to point out two results concerning time-independent integrals of motion in Dirac's theory of the electron, which to the author's best knowledge have not been stated heretofore in the literature. For the proofs of the theorems given below the reader is referred to the author's thesis.[1]

In what follows, we will be concerned with dynamical operators which commute with the Hamiltonian[2]

$$H = c\alpha^k\left(p_k + \frac{e}{c}\Phi_k\right) + mc^2\alpha^4 - e\Phi_0 \quad (k=1, 2, 3) \quad (1)$$