considerable improvement over the data on masses, and constitute the best present evidence that nuclei in this region are actually unstable. Exceptions, in the nature of fluctuations from the general trend, are of course to be anticipated.

The adoption of this view raises the question of the probability of the alpha-emission. Except in cases of extremely small energy changes, this must be very low to account for the failure of direct detection in these elements. This may, of course, be due sometimes to the necessity for multiple emission. Landé, however, suggests that the mechanism of ejection may require that the residual nucleus be left with a considerable excitation. Emission would then be probable only when the total energy of the change exceeds the necessary residual excitation. As pointed out independently in another connection in the former[2] paper there is some indication that the residual nucleus in many of the known alpha-changes is excited, even in cases where no gamma-rays are found. This perhaps offers support to Landé's suggestion.

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Energy States of Doubly Excited Helium

In a letter in the July 1st issue of the *Physical Review*, Fender and Vinti gave the result of their calculation of the lower states of doubly excited helium. They compared their result with the assignments of the two lines in the extreme ultraviolet by Kruger and of the corona lines by Rosenthal.[1] Dr. Goudsmit and the writer, in an attempt to examine the possible relation of the spectrum of doubly excited helium and the corona spectra, have also undertaken similar calculations of the approximate positions of the levels of doubly excited helium. A modified form of the variational method[2] was employed; hydrogenic wave functions were used and two "screening constants," one for each electron, introduced as variational parameters with respect to which the energy integral is to be minimized. As the finding of the exact minimum in some cases requires a considerable amount of numerical computations, we are content at present with approximate values of the minima. The preliminary result of such calculations is given in Table I. The energies in column (1) are in units of R, measured from the state of the naked nucleus, those in column (2) are in wave numbers above the first ionization limit of helium. For comparison, the values obtained by Fender and Vinti are given in column (3).

The relative positions of these levels show some unexpected features. The level $2s2p\,^3P$ is lower than $2s^2\,^1S$, whereas a superficial comparison with the normal helium spectrum might falsely suggest the opposite is the case. That this can be so is easily understood without any detailed calculations. The electrostatic repulsion between two electrons both in the $2s$ state will be greater than for the $2s2p$ configuration and as the energy of a single $2s$ or $2p$ electron in He^+ is practically the same, the $2s^2\,^1S$ will be higher than $2s2p$. The exchange energy complicates these considerations somewhat and the calculations show that the $2s2p\,^1P$ state is considerably higher than the ^3P of this configuration, and that the $2s^2\,^1S$ lies between these two multiplets. Another result is that the levels of the $2p^2$ configuration have low positions.

TABLE I.

State	Energy (1)	(2)	(3)
$2s4d^1\,^3D$	$-1.062\ R$	322,000 cm^{-1}	
$2s4s\ ^1S$	-1.090	319,200	
$2s4s\ ^3S$	-1.102	318,000	
$2s3d\ ^1D$	-1.110	317,000	
^3D	-1.112	316,800	
$2s3p\ ^1P$	-1.126	315,000	
^3P	-1.146	313,000	
$2s3s\ ^1S$	-1.175	310,000	
$2s3s\ ^3S$	-1.222	304,600	
$2s2p\ ^1P$	-1.308	295,000	296,118
$2p^2\,^1D$	-1.320	294,000	
$2s^2\,^1S$	-1.445	280,000	275,000
$2s2p\ ^3P$	-1.504	274,000	274,526
$2p^2\,^3P$	-1.662	256,000	

The spectrum of doubly excited helium calculated from the states in Table I is given in Table II.

TABLE II.

Possible transition	Wave number
$2s^2\,^1S-2s3s\,^1P$	35,000 cm^{-1}
$2s2p\,^1P-2s4d\,^1D$	27,000
$2s2p\,^3P-2s3s\,^3S$	30,000
$2s2p\,^1P-2s4s\,^1S$	24,000
$2p^2\,^1D-2s3p\,^1P$	21,000
$2s2p\,^1P-2s3d\,^1D$	22,000
$2p^2\,^3P-2s2p\,^3P$	18,000
$2s^2\,^1S-2s2p\,^1P$	15,000
$2s2p\,^1P-2s3s\,^1S$	15,000

These energy levels and wave numbers of possible transition are, on account of the nature of the calculation, only rough approximations. A partial support, however, is given by the two lines observed by Kruger and Paschen in the far ultraviolet spectrum of He (λ320.4 and λ357.5). Using the energy levels calculated above, we find,[3]

$1s2s\ ^3S-2s2p\ ^3P$	314,000 cm^{-1}	observed lines
$1s2p\,^1P-\ 2s^2\,^1S$	311,000 "	312,117 cm^{-1}
$1s2p\,^3P-\ 2p^2\,^3P$	289,000 "	279,715 "

In a separate paper[4] the possible relation of the spectrum of doubly excited He with the solar coroner spectrum is discussed.

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[1] Rosenthal, Zeits. f. Astrophysik **1**, 115 (1930).
[2] C. Eckart, Phys. Rev. **36**, 878 (1930).
[3] This agreement, however, should not be stressed upon too much, for the energy involved in these transitions is in the main part the excitation of an electron from $1s$ to $2s$ or $2p$ state. Furthermore, the numerical error in the calculation of states can easily be 0.005 R corresponding to about 500 cm^{-1}, not to say the inaccuracy inherent in such *methods* of calculation.
[4] Goudsmit and Ta-You Wu, to appear presently in the Astrophys. J.