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The Ground and First Excited Torsional States of Acetic Acid

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A global fit of microwave and millimeter-wave rotational transitions in the ground and first excited torsional states (v_t = 0 and 1) of acetic acid (CH_3COOH) is reported, which combines older measurements from the literature with new measurements from Kharkov, Lille, and NIST. The fit uses a model developed initially for acetaldehyde and methanol-type internal rotor molecules. It requires 34 parameters to achieve a unitless weighted standard deviation of 0.84 for a total of 2518 data and includes *A*- and *E*-species transitions with $J \leq 30$ and $K_a \leq 15$. While these results represent a significant improvement over past fitting attempts, it should be cautioned that the present data set is dominated by $v_t = 0$ transitions, and no direct infrared measure of the $v_t = 1 \leftarrow 0$ torsional interval is available. © 2001 Academic Press

I. INTRODUCTION

Acetic acid (CH_3COOH) is of astrophysical interest, since several of its rotational transitions have recently been detected in space (*1*). There is considerable interest in the detection of interstellar acetic acid because in the laboratory a bimolecular synthesis of the simplest important amino acid, glycine (NH_2CH_2COOH), occurs when acetic acid combines with NH_2^+, followed by release of a proton. Furthermore, the detection of isomeric pairs such as acetic acid and methyl formate $HCOOCH_3$ (which has been found with large column densities in Orion A and Sgr B2 (e.g., Refs. (*2–4*)) is important for the understanding of chemical reactions in the interstellar medium. In spite of intensive radio searches, however, and in spite of the relatively intense rotational spectrum expected from its dipole moment components μ_b = 1.47 D and μ_a = 0.86 D (*5*) (1 D = 3.33564×10^{-30} Cm), the first radio detection of acetic acid was only realized in 1997 in the Sgr B2 large-molecule Heimat source (*1*), using frequencies of the $8_{*,8}$–$7_{*,7}$ *A* and *E* lines measured at 90 246.26(5) and 90 203.35(5) MHz, respectively, at the National Institute of Standards and Technology (NIST). The $9_{*,9}$–$8_{*,8}$ *A* and *E* lines of CH_3COOH calculated at 100 897.83 and 100 855.02 MHz, respectively, by Wlodarczak and Demaison (*6*) were subsequently used to confirm this detection. Each of the lines with a * in place of K_a consists of four unresolved overlapping transitions, two *a*-type and two *b*-type. The 90 203-MHz line, for example, contains the *a*-type 8_{08}–7_{07} *E* and 8_{18}–7_{17} *E* transitions and the *b*-type 8_{08}–7_{17} *E* and 8_{18}–7_{07} *E* transitions (*1*).

A fair amount of spectroscopic ground state work is available in the literature for the acetic acid molecule (*5–10*). A very early study was published in 1957 by Tabor (*7*), who measured 11 lines for the normal species and 13 lines for the deuterated species. Later Krisher and Saegebarth measured and assigned 77 torsional ground state lines for the normal species and 54 lines belonging to the deuterated species CD_3COOH (*5*). Using the principal axis method (PAM) and a model extended to include perturbation terms through sixth order, they were able to determine a value for the torsional barrier of V_3 = 168.2(2) cm^{-1} (480.8(5) cal/mol). Stark-effect measurements gave electric dipole moment components of μ_a = 0.86(1) D and μ_b = 1.47(2) D. In 1981 van Eijck *et al.* (*8*) performed 67 new measurements and remeasurements in the frequency range from 27 to 40 GHz in the ground torsional state (v_t = 0) of acetic acid. Using both the PAM and IAM (internal axis method), they succeeded in fitting the *A*-species frequencies to experimental precision, but the *E*-species root-mean-square (rms) deviations were 1.64 and 0.70 MHz for the PAM and IAM methods, respectively. In 1982, Demaison *et al.* (*9*) measured lines in the 70–290 GHz and 28–39 GHz ranges, but again the rms deviations were large for *E*-species lines. The first excited torsional state (v_t = 1) of acetic acid was investigated by van Eijck and collaborators up to J = 21 in 1983 (*10*). The observed-minus-calculated values showed severe discrepancies, some as large as several megahertz. In 1988, Demaison and Wlodarczak (*6*) extended measurements of the ground torsional state to frequencies up to 362 GHz.

Supplementary data for this article are available on IDEAL (http://www.idealibrary.com) and as part of the Ohio State University Molecular Spectroscopy Archives (http://msa.lib.ohio-state.edu/jmsa_hp.htm).

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The present study reports a global fit of over 2500 rotational transitions in acetic acid, using the same rho axis method (RAM) that was previously applied to the four lowest torsional states of acetaldehyde CH_3CHO (*11*) and the two lowest torsional states of methanol CH_3OH (*12*). Just as for those two molecules (*13, 14*), we want ultimately to provide a frequency and intensity atlas of measured and calculated lines that can be used for further astrophysical detection, but it seemed prudent as a first step to establish confidence limits and identify shortcomings in the theoretical model and experimental data set. Transition frequencies were taken from four sources (which for various reasons were put into the fit in the following chronological order): (i) most measurements published in the references listed above (provided they were not remeasured as part of the present work), (ii) new lines from Lille, measured using broadband recording in various frequency intervals in the region from 148 to 250 GHz, (iii) new lines from NIST, both molecular-beam-cooled Fourier transform lines from 8 to 40 GHz, and submillimeter lines from 78 to 118 GHz, 300 to 304 GHz, and 350 to 365 GHz, and (iv) published (*15*) (*A*-species) and unpublished (*E*-species) lines from Kharkov, in the region from 49 to 155 GHz. Our main effort was focused on the torsional ground state, but several hundred $v_t = 1$ transitions are also included in the present fit.

II. EXPERIMENTAL DETAILS

Measurements from Lille

Measurements in Lille were made in the 148–250 GHz range. The millimeter-wave sources were second and third harmonics of a 74–80 GHz phase-locked Gunn diode and a Russian Istok backward-wave oscillator working in the 170–250 GHz range. The lines were detected with a liquid-He-cooled InSb bolometer. The spectrometer was used in a scanning mode with a frequency step of 50 kHz. The uncertainty of the measurements is estimated to be less than 100 kHz. The sample of CH_3COOH was obtained from Aldrich Chemical Co., Inc. (*16*) and used without further purification.

Measurements from NIST

Fourier transform microwave (FTMW) measurements at NIST were carried out from 8 to 40 GHz. A sample consisting of 6.5 Torr (1 Torr = 133.3 Pa) of glacial acetic acid was placed in an evacuated cylinder. The tank was then pressurized to 5000 Torr with an inert carrier gas consisting of 20% helium in neon by volume, resulting in a mixture of 0.13% by volume. For measurements below 26.5 GHz, one of the standard NIST instruments was used. The electronics, hardware, and software are identical to the smaller FTMW instrument (*17*). For measurements between 26.5 and 40 GHz, some additional microwave hardware was used. Referring to Fig. 3 of Ref. (*17*), active doublers were inserted after the programmable attenuators and between S1 and the image rejection mixer. The microwave amplifier located immediately after the Fabry–Perot cavity, S3, and the image rejection mixer were replaced with units designed to operate in the 26.5–40 GHz region. The 60-MHz intermediate frequency (IF) signal from the mixer was mixed with a 90-MHz signal. The resulting difference frequency (30 MHz) was then digitized directly at 8 MHz as described in Ref. (*17*). In all of these experiments the pulsed nozzle was mounted on the back side of one of the Fabry–Perot cavity mirrors so that the gas pulse travels coaxially with the Fabry–Perot cavity axis (*18*). This results in lines with about 10 kHz full width at half-maximum. As described in Ref. (*17*), all frequencies are referenced to a 10-MHz frequency obtained from a Loran-C receiver. This frequency is referenced to a Cs-clock which has stability on the order of 1 part in 10^{11}.

For measurements in the 300–304 and 350–365 GHz spectral regions, a spectrometer consisting of a broadband tunable ISTOCK backward-wave oscillator, phase-locked to a precision-tunable 53–78 GHz KVARTZ synthesizer was used. The signal passes through an absorption cell 3 m long and is focused on a high-sensitivity liquid-He-cooled InSb hot-electron bolometer. For measurements in the 78–118 GHz range a broadband precision-tunable KVARTZ synthesizer was used directly as the source. In both cases the cell was maintained at 7 mTorr of acetic acid under mild flow conditions to avoid impurities. Frequency detection was the same as for the FTMW measurements.

Measurements from Kharkov

Measurements of the spectra were carried out using an automated spectrometer in the millimeter region (*19*). The spectrometer employs a computer-controlled synthesizer in the frequency range of 50–120 GHz as a source of millimeter-wave radiation. It is designed for detailed investigation of the spectra of molecules with very high resolution. The synthesis of the frequencies in the millimeter region is carried out by a two-step frequency multiplication of the reference synthesizer (390–400 MHz) in two phase-lock-loop (PLL) stages. The first PLL stage utilizes a Klystron generator in the range of 3.4–5.2 GHz. In the second stage, the backward-wave oscillator (BWO) tube is locked to a harmonic of the Klystron. By changing the BWO and the corresponding elements of the waveguide components, the frequency region from 50 to 120 GHz can be covered. Investigation of the energy spectrum of the synthesizer indicates that the output spectral bandwidth does not exceed 1 kHz. Measurements are carried out with the use of frequency modulation (FM) of the synthesizer radiation. The lines are detected with a room-temperature Schottky diode detector. The long-term frequency stability is completely determined by the stability of the rubidium frequency standard.

For the work here, the spectrometer has been extensively modified as compared to the original version described in Ref. (*19*). Thus, in place of the selective amplifier in the detection system, a broadband (10–300 kHz) low-noise amplifier was used. This permits us to vary the frequency modulation over a broad range and allows the use of frequency modulation not only in the first, but also in the second stage of the PLL, in order to reach the highest resolution with a very small frequency and index of modulation. The Lamb dip in the spectrum of SO_2 was recorded with a width of 0.015 MHz at a frequency around 70 GHz.

After upgrading the hardware and software of the spectrometer, a completely automated procedure was introduced for all the PLL systems. With these upgrades in place, the spectrometer is capable of continuous recording of spectra in all operating frequency regions. Broadband survey scans are carried using comparatively large (up to 50 kHz) frequency steps. In this way, the entire frequency region of the spectrometer (50–150 GHz) can be recorded in several days. These large survey scans are useful in the initial stages of the investigations since they give a general spectral overview. Shortcomings of the survey spectrum consist of some lowering of the precision of the frequency measurements of the transitions (uncertainties from 10 to 50 kHz) and a lower signal/noise ratio. However, since the survey scans are followed by high-resolution measurements, these shortcomings are tolerable.

The complete spectrum of acetic acid in the working region of the spectrometer was recorded in the survey mode with a frequency step of 30 kHz. The uncertainty of these measurements is estimated to be not worse than 10 kHz for an isolated line. This recording of the spectrum was obtained using a single pass absorption cell (*20*) at room temperature. The pressure in the cell was maintained at a level that insured maximum sensitivity. Under these conditions the width of the lines was near the Doppler limit and did not exceed 0.3 MHz. A total of about 13 000 transitions were recorded, corresponding to various states of CH_3COOH. To increase the frequency measurement accuracy, a number of the transitions were rerecorded at high resolution (Doppler-limited linewidth). Additionally, the frequency range was extended to 155 GHz using a frequency doubler.

III. THEORETICAL MODEL

Rather complete descriptions of the theoretical model used in the present study exist in the literature, since its most recent version has now been applied to a number of molecules containing a C_{3v} internal rotor and an asymmetric C_s molecular frame, e.g., acetaldehyde CH_3CHO (*11*), methanol CH_3OH (*12*), methyl mercaptan CH_3SH (*21*), trifluoropropene CF_3CHCH_2 (*22*), deuterated acetaldehyde CD_3CHO (*23*), and several methanol isotopomers (*24*, *25*). We thus give here only the main characteristics.

The Hamiltonian used is the so-called RAM internal–rotation Hamiltonian based on the work of Kirtman (*26*), Lees and Baker (*27*), Herbst *et al.* (*28*), and Liang *et al.* (*29*). The method takes its name from the choice of axis system (*30*), the rho axis system, which is related to the principal axis system *a*, *b*, *c* by a rotation chosen to eliminate the $-2FP_\gamma\rho_xJ_x$ and $-2FP_\gamma\rho_yJ_y$ coupling terms in the kinetic energy operator, where F is the internal rotation constant, P_γ is the internal rotation angular momentum, J_x and J_y are the usual x and y components of the global rotation angular momentum, and $\boldsymbol{\rho}$ is a vector that expresses the coupling between the angular momentum of the internal rotation P_γ and that of the global rotation $\mathbf{J}$. Rotation to the RAM axis system corresponds to making the new z axis coincident with the $\boldsymbol{\rho}$ vector, since $\rho_x = \rho_y = 0$ by definition. The advantage of the resulting RAM Hamiltonian for computation arises from the fact that all low-order operators containing the torsional angle γ and its conjugate momentum P_γ are diagonal in the rotational quantum number K. All operators off-diagonal in K then appear only in the rotational part of the problem. The method starts with a one-dimensional threefold periodic potential function $V(\gamma)$ together with a torsion–rotation kinetic energy operator diagonal in K. In the first step a set of torsional calculations, one for each value of K and Γ (where $\Gamma = A$ or E), is carried out using a 21-function torsional basis set. This basis set is then reduced in size by discarding all but the nine lowest torsional eigenfunctions for given K and Γ. We verified that these two truncations of the Hamiltonian matrix did not modify the energy levels at the level of measurement precision. The retained torsional eigenfunctions are multiplied by symmetric-top rotational functions $|J, K, M\rangle$ to form a basis set which is used to diagonalize, in a second step, zeroth-order asymmetric-rotor terms and higher order terms obtained by multiplying torsional operators with rotational operators. (Note, as indicated later in Table 2, that powers of P_γ itself, rather than powers of $(P_\gamma - \rho J_z)$, are used to construct such higher order operators in this work.)

Acetic acid has three characteristics that the RAM program never had to face before, and this makes it an excellent molecule to test performance of the method in a different limiting case. First, the torsional potential barrier is rather low ($V_3 \approx 168$ cm^{-1}) so torsional splittings can reach several gigahertz even in the torsional ground state. (From a reduced barrier point of view, however, the torsional problem is somewhere between that for methanol and that for acetaldehyde, since $s \equiv 4V_3/9F$ is 6.0 for methanol, 14.5 for acetic acid, and 23.7 for acetaldehyde.) Figure 1 shows a plot of the lowest torsional levels of acetic acid in its threefold potential well, indicating that the $v_t = 2$ level straddles the top of the barrier. (The two lowest small-amplitude vibrations (*31*), the CO torsion ν_{17} at 534 cm^{-1} and the CCO deformation ν_{12} at 581 cm^{-1}, are well above the top of the barrier.) To avoid complications from incipient free-rotor states, we have confined our attention in this paper to the $v_t = 0$ and 1 levels, which lie completely below the top of the barrier.

Second, contrary to all previous molecules we have investigated, acetic acid is a fairly heavy, somewhat oblate internal rotor ($\kappa = +0.38$), with the methyl top internal rotation axis perpendicular to the near symmetric-top axis of the molecule, rather than approximately parallel to it. For this reason, K_c will

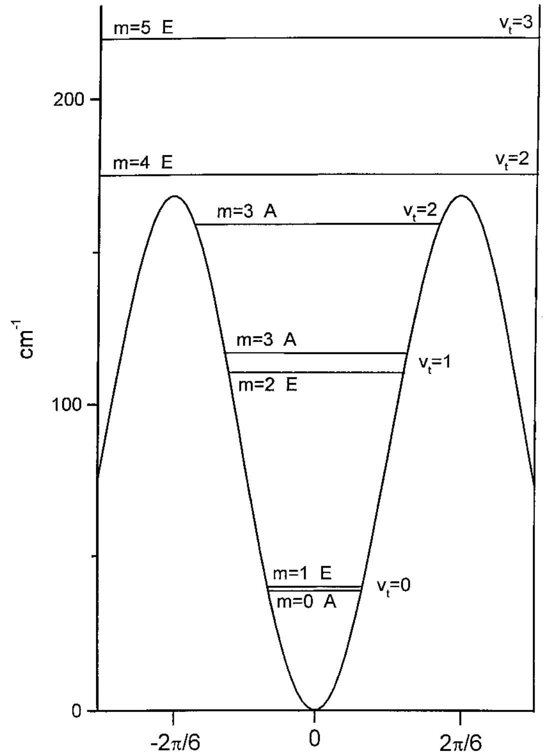

FIG. 1. Low-lying torsional energy levels of acetic acid. The free-rotor quantum number m is given on the left. This quantum number is not well defined for levels below the barrier. The harmonic oscillator vibrational quantum number v_t is given on the right. This quantum number is not well defined for levels above the barrier.

often be a better quasi-quantum number than K_a (though our computer program is set up in a K_a symmetric-top basis set) and transitions will cluster differently than in a near-prolate top molecule. For example, calculations based on the present fit indicate that for $J = 15$, the $J_{J-Kc+1,Kc}$ and $J_{J-Kc,Kc}$ A-species pairs are degenerate to less than 1 kHz for $K_c = 15$, 14, and 13 ($K_a = 0$, 1, 2, and 3) for both $v_t = 0$ and 1. This relatively uncommon very tight clustering behavior prompted the use of the unorthodox $8_{*,8}$–$7_{*,7}$ and $9_{*,9}$–$8_{*,8}$ notation in the astronomical searches (*1*). It also means that our count of 2500 transitions is somewhat misleading, in the sense that one measured frequency can sometimes be counted as four different transitions.

Third, the ratio of the methyl top moment of inertia to that of the rest of the molecule is small. The resultant small value for ρ of 0.08 (compared, for example, to values near 0.3 for acetaldehyde CH_3CHO, 0.8 for methanol CH_3OH, and 0.5 for CD_3CHO), leads to a relatively small coefficient for the coupling term between internal rotation and global rotation. One effect of the small value of ρ is to lengthen the period of the cosine function describing torsional splittings in Eq. [4] of Ref. (*30*), as well as of the sine function in Eq. [6] and Fig. 2 there, so that for the $F(P_\gamma - \rho K)^2$ sign choice in our program, the $+K_a$ E-species levels with $v_t = 0$ ($v_t = 1$) lie below (above) the $-K_a$ levels in the large interval from $|K_a| = 1$ to $|K_a| = 19$.

It should be noted that for fits of the acetic acid spectrum presented here we have changed from the $F(P_\gamma + \rho K)^2$ sign convention used in all previously published fits from the present computer program to the $F(P_\gamma - \rho K)^2$ convention. The minus sign arises naturally in the derivation of the Hamiltonian operator when γ is defined to measure the orientation of the top with respect to that of the frame. (See Sections 2IIA and 2IIB of Ref. (*32*), Section 3 of Ref. (*30*), and Section II of Ref. (*33*).) The main consequences of such a sign change in the Hamiltonian operator (if ρ is kept positive) are to change the signs of the $+K_a$, $-K_a$ energy-level labels for E-species transitions in the data set and to change the signs returned by the global least-squares fit for molecular constants multiplying operators which go into their negatives when $\gamma \rightarrow -\gamma$. These consequences can be deduced by noting that the desired sign change can be accomplished formally by changing the sign of the internal rotation angle (*33*).

The partially resolved hyperfine structure observed for some transitions at the 10-kHz Fourier transform resolution, which presumably arises from spin–spin and/or spin–rotation interactions involving the four hydrogen nuclei, has not been addressed theoretically. As Fig. 2 illustrates, many low J transitions in CH_3COOH involving A-species levels appear as clear weak–strong–weak triplets, whereas the analogous transitions involving E-species levels appear as singlets. As Fig. 2 also illustrates, this same pattern is exhibited by transitions in CH_3CHO, a closely related chemical structure consisting of boson nuclei plus four protons. At present, this empirical regularity has only been used as a consistency check for A/E assignments. Also, since the frequency of the strongest component is used directly in the fits, the assigned uncertainty of 4 kHz may be somewhat optimistic for these hyperfine-split lines.

IV. ASSIGNMENTS AND FIT

The assignment procedure began by collecting and fitting all previous measurements in the literature for the ground ($v_t = 0$) and first excited ($v_t = 1$) torsional states (*5–10*). The predictions obtained were sufficiently good to allow us to assign a number of new transitions, update the fit, and then iterate the procedure through additional cycles. Our confidence in the $v_t = 0$ line assignments is high because (i) the cold (several Kelvin) and very precise NIST Fourier transform measurements can only be assigned to very low J and K transitions with $v_t = 0$, (ii) the extensive and precise Kharkov measurements include a large number of four-line loops whose frequencies sum to zero within experimental error, and (iii) the set of assigned ground torsional state transitions, which provide a relatively dense coverage of the rotational quantum number ranges $0 \leq J \leq 30$ and $0 \leq K_a \leq 15$, all fit well to a theoretical model which has been thoroughly tested on other

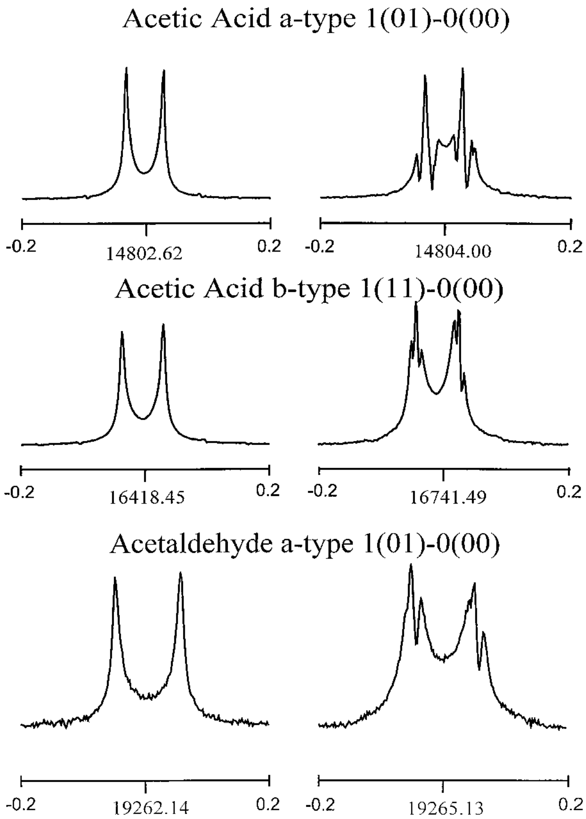

FIG. 2. Six spectral traces illustrating similarities and differences in the hyperfine structure of $J = 1 \leftarrow 0$ transitions. Abscissa labels are in megahertz. The ordinate scale is arbitrary intensity units, with the noise level shown in the wings of the lines. The first two rows show the $1_{0,1}–0_{0,0}$ and $1_{1,1}–0_{0,0}$ transitions of acetic acid (with argon carrier). The third row shows the $1_{0,1}–0_{0,0}$ transitions of acetaldehyde (with neon carrier), which clearly resemble their acetic acid counterparts. The left column shows *E*-species transitions, which have no discernible hyperfine structure at the 10-kHz linewidth of the NIST jet-cooled Fourier transform microwave spectrometer. The right column shows *A*-species transitions, all of which appear to have three hyperfine components. The partially resolved hyperfine structure in this figure and the similar hyperfine structure observed for various other *A*-species transitions are not treated in this work. The frequency of the strong central component is used in the fits.

molecules. Our confidence in the $v_t = 1$ assignments and in the full parameter set returned by the fit is not quite so high, because the *J* and *K* coverage is still rather poor and there is as yet no direct measurement of the $v_t = 1 \leftarrow 0$ infrared transition frequency, i.e., all parameters must be determined from rotational energy spacings alone.

One of the most difficult problems in attempting to obtain a weighted standard deviation near unity from a global fit of a composite data set is the allocation of appropriate experimental uncertainties. If uncertainties are too lax, the theoretical model appears excellent even when misassignments and/or mismeasurements are present in the fit, leading to gross overconfidence in any calculated transitions. If uncertainties are too tight, the search for useful higher order terms in the model is endless. The weighting strategy chosen for the present work is the following. Poorly fitting transitions from the older literature, where possibilities of systematic or typographical errors cannot be reexamined, were arbitrarily given zero weight or uncertainties larger than stated in the article. The NIST molecular beam FTMW measurements, which are known from other work to have standard uncertainties of 1 or 2 kHz, have here been given uncertainties of 4 kHz, since we do not expect the Hamiltonian at our present stage of understanding to be accurate to more than a few kilohertz. Most of the Kharkov measurements, which comprise over half of our total data set and which are thought on the basis of a large number of combination difference loops to be accurate to 10 kHz or better, have been given a weight of 20 kHz, again to accommodate model errors. Similarly a number of $v_t = 1$ transitions from Ref. (*10*), though presumably accurate to 50 kHz, were given a weight of 200 kHz to accommodate model errors. Finally, lines calculated to be unresolved doublets were given weights commensurate with their calculated splittings.

The global fit finally chosen for the present work allowed 34 parameters to vary and gives microwave rms deviations of 41 kHz for 2109 $v_t = 0$ transitions and 93 kHz for 409 $v_t = 1$ transitions with $J \leq 30$, $K_a \leq 15$. The overall quality of the

TABLE 1
Root-Mean-Square Deviations from the Global Fit[a]

Number of parameters	34
Number of lines	2518
RMS of the 2109 MW $v_t = 0$ - 0 Lines	0.041 MHz
RMS of the 409 MW $v_t = 1$ - 1 Lines	0.093 MHz

Source[b]	Range[c] GHz	Lines[d]	Uncert[e] MHz	RMS[f] MHz
NIST FTMW	8-40	77	0.004	0.004
KHARKOV	49-155	1370	0.020	0.016
VARIOUS		868	0.050	0.044
LILLE	148-250	127	0.100	0.102
KRI71 & VAN83		72	0.200	0.204
NIST	350-365	4	1.000	0.434

[a] Parameter values are given in Table 2. Observed minus calculated residuals are given in Table 3 for $v_t = 0$ lines and in the archived material for $v_t = 1$.

[b] Sources for data: KHARKOV, LILLE, NIST = this work; VARIOUS = Refs. (*6, 8–10*) and this work (Kharkov and NIST non-FT); KRI71 = Ref. (*5*); VAN83 = Ref. (*10*).

[c] Range containing the measurements in a given row.

[d] Number of MW lines in each uncertainty group.

[e] One-sigma standard uncertainty in MHz used in the fit, which is sometimes larger than the apparatus capabilities because of model problems or unresolved doublets (see text).

[f] Root-mean-square deviation in MHz for each group.

TABLE 2
Torsion–Rotation Parameters Used for the Global Fit

nlm[a]	Operator[b]	Parameter[b]	Value[c]	*nlm*[a]	Operator[b]	Parameter[b]	Value[c]
220	$\frac{1}{2}(1-\cos 3\gamma)$	V_3	170.217(1)	413	$P_\gamma P_a^3$	k_1	$-0.1163(7)\times10^{-5}$
	P_γ^2	F	5.62160(3)		$P_\gamma\{P_a,(P_b^2-P_c^2)\}$	c_4	$0.1744(1)\times10^{-5}$
211	$P_\gamma P_a$	ρ	0.0719483(3)	404	$-P^4$	D_J	$0.14318(4)\times10^{-6}$
202	P_a^2	A	0.3777291(7)		$-P^2P_a^2$	D_{JK}	$0.3491(2)\times10^{-6}$
	P_b^2	B	0.3166921(2)		$-P_a^4$	D_K	$-0.59(6)\times10^{-8}$
	P_c^2	C	0.17766123(7)		$-2P^2(P_b^2-P_c^2)$	δ_J	$0.5737(2)\times10^{-7}$
	$(P_aP_b+P_bP_a)$	D_{ab}	-0.0040735(3)		$-\{P_a^2,(P_b^2-P_c^2)\}$	δ_K	$0.35144(8)\times10^{-6}$
440	P_γ^4	k_4	$-0.211(1)\times10^{-3}$		$(P_aP_b+P_bP_a)P^2$	D_{abJ}	$-0.328(5)\times10^{-7}$
	$\frac{1}{2}(1-\cos 6\gamma)$	V_6	-6.6390(6)	642	$(1-\cos 6\gamma)P^2$	N_v	$0.305(2)\times10^{-4}$
431	$P_\gamma^3P_a$	k_3	$0.287(3)\times10^{-4}$		$(1-\cos 6\gamma)P_a^2$	K_2	$-0.45(2)\times10^{-4}$
422	$P_\gamma^2P^2$	G_v	$-0.563(1)\times10^{-5}$		$(1-\cos 6\gamma)(P_b^2-P_c^2)$	c_{11}	$0.133(2)\times10^{-4}$
	$2P_\gamma^2(P_b^2-P_c^2)$	c_1	$-0.1969(4)\times10^{-5}$	624	$(1-\cos 3\gamma)P^2P_a^2$	k_{5J}	$0.108(3)\times10^{-7}$
	$(1-\cos 3\gamma)P^2$	F_v	$-0.3550(2)\times10^{-3}$		$(1-\cos 3\gamma)P_a^4$	k_{5K}	$-0.118(8)\times10^{-7}$
	$(1-\cos 3\gamma)P_a^2$	k_5	$0.557(2)\times10^{-3}$		$P_\gamma^2\{P_a^2,(P_b^2-P_c^2)\}$	c_{1K}	$0.256(4)\times10^{-9}$
	$(1-\cos 3\gamma)(P_b^2-P_c^2)$	c_2	$-0.1912(2)\times10^{-3}$	606	P^6	H_J	$0.285(8)\times10^{-12}$
	$(1-\cos 3\gamma)(P_aP_b+P_bP_a)$	d_{ab}	$-0.22242(3)\times10^{-2}$		$2P^4(P_b^2-P_c^2)$	h_J	$0.125(4)\times10^{-12}$
413	$P_\gamma P_aP^2$	L_v	$0.3218(2)\times10^{-5}$		$P^2\{P_a^2,(P_b^2-P_c^2)\}$	h_{JK}	$0.67(2)\times10^{-12}$

[a] Notation of Ref. (*11*); n = 1 + m, where n is the total order of the operator, 1 is the order of the torsional part and m is the order of the rotational part, respectively.

[b] Notation of Ref. (*11*). {A, B} = AB + BA. The product of the parameter and operator from a given row yields the term used in the torsion-rotation Hamiltonian, except for F, ρ and A, which occur in the Hamiltonian in the form $F(P_\gamma - \rho P_a)^2 + AP_a^2$.

[c] Values of the parameters from the fit shown in Table 3. All values are in cm^{-1}, except for ρ which is unitless. Type A statistical uncertainties are shown as one standard uncertainty in the last digit.

fit is illustrated in Table 1, which gives rms deviations for transitions grouped according to their measurement uncertainties (weight in the fit). Although we fit both *A*- and *E*-species transitions simultaneously, we calculate separate rms deviations for *A* (61 kHz) and *E* (43 kHz) lines to demonstrate the similar quality of the fit for the two symmetry species. These results represent a very significant improvement over past studies, where the *E* species could not be reproduced as well as the *A* species, and overall standard deviations rarely approached experimental precision.

Table 2 presents values and one-sigma standard uncertainties for the 34 parameters used to obtain the fit summarized in Table 1. Before choosing this "best" set of parameters, we examined a large number of other fits. As might be expected (*34, 35*), parameter values vary significantly (over thousands of standard uncertainties) when fundamental changes in the parameter set are made. For example, V_3 changed from 170.2 to 168.4 cm^{-1} and V_6 changed from -6.6 to -3.2 cm^{-1} when the term $k_7\{(1 - \cos 3\gamma), P_\gamma^2\}$ was included in the Hamiltonian. Some of these uncertainties in choice of parameter set can be removed by treating more extensive data sets, but some will remain because of arbitrary implicit contact transformation choices (*34, 35*).

Table 3 presents all $v_t = 0$ transition frequencies included in the fit, together with their assignments, observed minus calculated residuals, and laboratory of origin. When the same transition was measured in more than one laboratory, only the frequency with the lowest uncertainty was included in the fit in most cases. Agreement between duplicate measurements from the three laboratories contributing new data to this paper was excellent, i.e., mostly within the stated uncertainty limits. Transitions in Table 3 are not ordered by frequency, but are rather grouped into spectroscopic branches, so that model inadequacies can more easily be recognized by examining observed-minus-calculated trends along a branch. Ground state transitions of *A* species are given first. Some branches with $|\Delta K_a| > 1$ are included at appropriate places. Branches with $|\Delta K_c| > 1$ were not systematically searched for in the present work, but branches with $|\Delta K_c|$ = even are forbidden by symmetry for *A* species. The $v_t = 0$ transitions of *E* species are given next. A few $|\Delta K_c|$ = even transitions are included, since these are not symmetry forbidden for *E* species. The smaller number of $v_t = 1$ transitions (*A* and *E* species) are not given here; they can be found in the archived material.

V. DISCUSSION

We present here the first global study of rotational levels with $J \le 30$ and $K_a \le 15$ in the lowest two torsional states of acetic acid, using a torsion–rotation Hamiltonian which has proved to be a powerful tool for the analysis of microwave, millimeter-wave, and far-infrared data of internal C_{3v} rotors. This study represents a good starting point for further investi-

TABLE 3

Assignments,[a] Observed Frequencies,[b] Residuals from the Fit,[c] and Data Sources[d] for Microwave Transitions within the $v_t = 0$ State

J'	Ka'	Kc'	P'	J"	Ka"	Kc"	P"	Observed (Unc)	O - C	Source
1	0	1	+	0	0	0	+	14804.002(4)	-0.001	NIST
2	0	2	+	1	0	1	+	26858.036(4)	-0.001	NIST
3	0	3	+	2	0	2	+	37217.426(4)	0.002	NIST
6	0	6	+	5	0	5	+	68944.811(20)	-0.006	KHARK
7	0	7	+	6	0	6	+	79595.154(50)	0.024	KHARK
8	0	8	+	7	0	7	+	90246.250(50)	-0.013	KHARK
9	0	9	+	8	0	8	+	100897.459(20)	0.005	KHARK
10	0	10	+	9	0	9	+	111548.533(20)	0.002	KHARK
11	0	11	+	10	0	10	+	122199.428(20)	0.001	KHARK
12	0	12	+	11	0	11	+	132850.105(50)	0.005	KHARK
13	0	13	+	12	0	12	+	143500.523(20)	0.006	KHARK
14	0	14	+	13	0	13	+	154150.570(50)	-0.080	DEM82
16	0	16	+	15	0	15	+	175450.120(100)	0.149	LILLE
19	0	19	+	18	0	18	+	207396.240(50)	-0.008	DEM82
20	0	20	+	19	0	19	+	218044.210(50)	0.009	DEM82
21	0	21	+	20	0	20	+	228691.770(50)	0.055	DEM82
26	0	26	+	25	0	25	+	281922.010(50)	0.005	DEM82
27	0	27	+	26	0	26	+	292566.460(50)	-0.005	DEM82
28	0	28	+	27	0	27	+	303210.217(50)	-0.128	NIST
1	1	1	+	0	0	0	+	16741.494(4)	0.002	NIST
2	1	2	+	1	0	1	+	27394.077(4)	0.001	NIST
3	1	3	+	2	0	2	+	37314.562(4)	0.002	NIST
6	1	6	+	5	0	5	+	68945.066(20)	0.000	KHARK
7	1	7	+	6	0	6	+	79595.154(50)	-0.006	KHARK
8	1	8	+	7	0	7	+	90246.250(50)	-0.017	KHARK
9	1	9	+	8	0	8	+	100897.459(20)	0.005	KHARK
10	1	10	+	9	0	9	+	111548.533(20)	0.002	KHARK
11	1	11	+	10	0	10	+	122199.428(20)	0.001	KHARK
12	1	12	+	11	0	11	+	132850.105(20)	0.005	KHARK
13	1	13	+	12	0	12	+	143500.523(20)	0.006	KHARK
14	1	14	+	13	0	13	+	154150.570(50)	-0.080	DEM82
16	1	16	+	15	0	15	+	175450.120(100)	0.149	LILLE
19	1	19	+	18	0	18	+	207396.240(50)	-0.008	DEM82
20	1	20	+	19	0	19	+	218044.210(50)	0.009	DEM82
21	1	21	+	20	0	20	+	228691.770(50)	0.055	DEM82
26	1	26	+	25	0	25	+	281922.010(50)	0.005	DEM82
27	1	27	+	26	0	26	+	292566.460(50)	-0.005	DEM82
28	1	28	+	27	0	27	+	303210.217(50)	-0.128	NIST
2	1	1	-	2	0	2	+	12989.907(4)	0.000	NIST
3	1	2	-	3	0	3	+	23540.213(4)	-0.001	NIST
4	1	3	-	4	0	4	+	34487.750(50)	0.010	VAN81
6	1	5	-	6	0	6	+	54999.502(50)	0.011	KHARK
7	1	6	-	7	0	7	+	65078.606(20)	-0.004	KHARK
8	1	7	-	8	0	8	+	75142.040(20)	0.006	KHARK
9	1	8	-	9	0	9	+	85199.168(50)	0.036	KHARK
10	1	9	-	10	0	10	+	95252.324(20)	0.004	KHARK
11	1	10	-	11	0	11	+	105302.500(20)	0.016	KHARK
12	1	11	-	12	0	12	+	115350.048(20)	0.001	KHARK
13	1	12	-	13	0	13	+	125395.228(20)	-0.008	KHARK
14	1	13	-	14	0	14	+	135438.171(20)	0.000	KHARK
16	1	15	-	16	0	16	+	155517.550(100)	0.089	LILLE
18	1	17	-	18	0	18	+	175588.160(100)	0.208	LILLE
2	0	2	+	1	1	1	+	24920.542(4)	-0.006	NIST
3	0	3	+	2	1	2	+	36681.388(4)	0.002	NIST
6	0	6	+	5	1	5	+	68942.861(20)	0.004	KHARK
7	0	7	+	6	1	6	+	79594.892(50)	0.011	KHARK
8	0	8	+	7	1	7	+	90246.250(50)	0.017	KHARK
9	0	9	+	8	1	8	+	100897.459(20)	0.009	KHARK
10	0	10	+	9	1	9	+	111548.533(20)	0.002	KHARK
11	0	11	+	10	1	10	+	122199.428(20)	0.001	KHARK
12	0	12	+	11	1	11	+	132850.105(20)	0.005	KHARK
13	0	13	+	12	1	12	+	143500.523(20)	0.006	KHARK
14	0	14	+	13	1	13	+	154150.570(50)	-0.080	DEM82
16	0	16	+	15	1	15	+	175450.120(100)	0.149	LILLE
19	0	19	+	18	1	18	+	207396.240(50)	-0.008	DEM82
20	0	20	+	19	1	19	+	218044.210(50)	0.009	DEM82
21	0	21	+	20	1	20	+	228691.770(50)	0.055	DEM82
26	0	26	+	25	1	25	+	281922.010(50)	0.005	DEM82
27	0	27	+	26	1	26	+	292566.460(50)	-0.005	DEM82
28	0	28	+	27	1	27	+	303210.217(50)	-0.128	NIST
3	2	1	+	2	0	2	+	73156.051(50)	0.034	KHARK

J'	Ka'	Kc'	P'	J"	Ka"	Kc"	P"	Observed (Unc)	O - C	Source
2	2	1	-	2	0	2	+	18800.649(4)	0.011	NIST
7	2	6	-	7	0	7	+	65081.743(20)	-0.022	KHARK
8	2	7	-	8	0	8	+	75142.472(20)	-0.006	KHARK
9	2	8	-	9	0	9	+	85199.168(50)	-0.023	KHARK
10	2	9	-	10	0	10	+	95252.324(20)	-0.004	KHARK
11	2	10	-	11	0	11	+	105302.500(50)	0.015	KHARK
12	2	11	-	12	0	12	+	115350.048(20)	0.000	KHARK
13	2	12	-	13	0	13	+	125395.228(20)	-0.008	KHARK
14	2	13	-	14	0	14	+	135438.171(20)	0.000	KHARK
16	2	15	-	16	0	16	+	155517.550(100)	0.089	LILLE
18	2	17	-	18	0	18	+	175588.160(100)	0.208	LILLE
2	1	2	+	1	1	1	+	25456.589(4)	0.002	NIST
3	1	3	+	2	1	2	+	36778.523(4)	0.001	NIST
6	1	6	+	5	1	5	+	68943.117(20)	0.011	KHARK
7	1	7	+	6	1	6	+	79594.892(50)	-0.019	KHARK
8	1	8	+	7	1	7	+	90246.250(50)	0.013	KHARK
9	1	9	+	8	1	8	+	100897.459(20)	0.008	KHARK
10	1	10	+	9	1	9	+	111548.533(20)	0.002	KHARK
11	1	11	+	10	1	10	+	122199.428(20)	0.001	KHARK
12	1	12	+	11	1	11	+	132850.105(20)	0.005	KHARK
13	1	13	+	12	1	12	+	143500.523(20)	0.006	KHARK
14	1	14	+	13	1	13	+	154150.570(50)	-0.080	DEM82
16	1	16	+	15	1	15	+	175450.120(100)	0.149	LILLE
19	1	19	+	18	1	18	+	207396.240(50)	-0.008	DEM82
20	1	20	+	19	1	19	+	218044.210(50)	0.009	DEM82
21	1	21	+	20	1	20	+	228691.770(50)	0.055	DEM82
26	1	26	+	25	1	25	+	281922.010(50)	0.005	DEM82
27	1	27	+	26	1	26	+	292566.460(50)	-0.005	DEM82
28	1	28	+	27	1	27	+	303210.217(50)	-0.128	NIST
2	1	1	-	2	1	2	+	12453.868(4)	-0.001	NIST
3	1	2	-	3	1	3	+	23443.078(4)	0.000	NIST
4	1	3	-	4	1	4	+	34473.227(4)	0.003	NIST
7	1	6	-	7	1	7	+	65078.606(20)	0.027	KHARK
8	1	7	-	8	1	8	+	75142.034(20)	0.003	KHARK
9	1	8	-	9	1	9	+	85199.168(50)	0.037	KHARK
10	1	9	-	10	1	10	+	95252.324(20)	0.004	KHARK
11	1	10	-	11	1	11	+	105302.500(50)	0.016	KHARK
12	1	11	-	12	1	12	+	115350.048(20)	0.001	KHARK
13	1	12	-	13	1	13	+	125395.228(20)	-0.008	KHARK
14	1	13	-	14	1	14	+	135438.171(20)	0.000	KHARK
16	1	15	-	16	1	16	+	155517.550(100)	0.089	LILLE
18	1	17	-	18	1	18	+	175588.160(100)	0.208	LILLE
2	2	1	-	2	1	2	+	18264.607(4)	0.008	NIST
3	2	2	-	3	1	3	+	25897.432(4)	0.004	NIST
4	2	3	-	4	1	4	+	35120.000(50)	-0.033	VAN81
6	2	5	-	6	1	6	+	55020.224(50)	0.008	KHARK
7	2	6	-	7	1	7	+	65081.743(20)	0.009	KHARK
8	2	7	-	8	1	8	+	75142.472(20)	-0.003	KHARK
9	2	8	-	9	1	9	+	85199.168(50)	-0.023	KHARK
10	2	9	-	10	1	10	+	95252.324(20)	-0.004	KHARK
11	2	10	-	11	1	11	+	105302.500(20)	0.015	KHARK
12	2	11	-	12	1	12	+	115350.048(20)	0.000	KHARK
13	2	12	-	13	1	13	+	125395.228(20)	-0.008	KHARK
14	2	13	-	14	1	14	+	135438.171(20)	0.000	KHARK
16	2	15	-	16	1	16	+	155517.550(100)	0.089	LILLE
18	2	17	-	18	1	18	+	175588.160(100)	0.208	LILLE
2	1	1	-	1	1	0	-	33759.142(4)	0.005	NIST
4	1	3	-	3	1	2	-	58634.283(50)	-0.003	KHARK
5	1	4	-	4	1	3	-	68673.642(20)	0.007	KHARK
6	1	5	-	5	1	4	-	79082.794(20)	0.008	KHARK
7	1	6	-	6	1	5	-	89674.250(20)	0.001	KHARK
8	1	7	-	7	1	6	-	100309.699(20)	0.011	KHARK
9	1	8	-	8	1	7	-	110954.592(50)	0.041	KHARK
10	1	9	-	9	1	8	-	121601.693(50)	-0.027	KHARK
11	1	10	-	10	1	9	-	132249.620(50)	0.029	DEM82
12	1	11	-	11	1	10	-	142897.668(20)	0.005	KHARK
13	1	12	-	12	1	11	-	153545.700(50)	-0.005	DEM82
18	1	17	-	17	1	16	-	206782.030(50)	0.020	DEM82
19	1	18	-	18	1	17	-	217428.120(50)	0.012	DEM82
20	1	19	-	19	1	18	-	228073.690(50)	-0.044	DEM82
21	1	20	-	20	1	19	-	238718.930(100)	0.071	LILLE

J'	Ka'	Kc'	P'	J"	Ka"	Kc"	P"	Observed (Unc)	O - C	Source
25	1	24	-	24	1	23	-	281293.930(50)	0.088	DEM82
26	1	25	-	25	1	24	-	291936.100(50)	0.012	DEM82
27	1	26	-	26	1	25	-	302577.544(50)	-0.146	NIST
2	2	1	-	1	1	0	-	39569.871(4)	0.004	NIST
3	2	2	-	2	1	1	-	50222.072(50)	-0.009	KHARK
4	2	3	-	3	1	2	-	59281.095(50)	0.000	KHARK
5	2	4	-	4	1	3	-	68799.951(50)	0.001	KHARK
6	2	5	-	5	1	4	-	79103.765(20)	0.005	KHARK
7	2	6	-	6	1	5	-	89677.405(20)	0.001	KHARK
8	2	7	-	7	1	6	-	100310.137(20)	0.005	KHARK
9	2	8	-	8	1	7	-	110954.592(50)	-0.019	KHARK
10	2	9	-	9	1	8	-	121601.693(50)	-0.035	KHARK
11	2	10	-	10	1	9	-	132249.620(50)	0.028	DEM82
12	2	11	-	11	1	10	-	142897.668(20)	0.005	KHARK
13	2	12	-	12	1	11	-	153545.700(50)	-0.005	DEM82
18	2	17	-	17	1	16	-	206782.030(50)	0.020	DEM82
19	2	18	-	18	1	17	-	217428.120(50)	0.012	DEM82
20	2	19	-	19	1	18	-	228073.690(50)	-0.044	DEM82
21	2	20	-	20	1	19	-	238718.930(100)	0.071	LILLE
25	2	24	-	24	1	23	-	281293.930(50)	0.088	DEM82
26	2	25	-	25	1	24	-	291936.100(50)	0.012	DEM82
27	2	26	-	26	1	25	-	302577.544(50)	-0.146	NIST
2	2	0	+	2	1	1	-	8560.604(4)	0.010	NIST
3	2	1	+	3	1	2	-	12398.379(4)	0.000	NIST
4	2	2	+	4	1	3	-	21463.441(4)	-0.002	NIST
5	2	3	+	5	1	4	-	33023.710(50)	-0.048	VAN81
7	2	5	+	7	1	6	-	54511.415(20)	-0.002	KHARK
8	2	6	+	8	1	7	-	64680.411(20)	-0.002	KHARK
9	2	7	+	9	1	8	-	74780.780(20)	-0.011	KHARK
10	2	8	+	10	1	9	-	84857.317(20)	0.004	KHARK
11	2	9	+	11	1	10	-	94921.873(50)	0.034	KHARK
12	2	10	+	12	1	11	-	104978.377(20)	-0.023	KHARK
13	2	11	+	13	1	12	-	115028.866(20)	0.001	KHARK
14	2	12	+	14	1	13	-	125074.286(20)	-0.002	KHARK
15	2	13	+	15	1	14	-	135115.310(20)	-0.004	KHARK
16	2	14	+	16	1	15	-	145152.380(50)	0.025	DEM82
17	2	15	+	17	1	16	-	155185.720(100)	0.045	LILLE
23	2	21	+	23	1	22	-	215313.000(50)	0.017	DEM82
4	1	3	-	3	2	2	-	56179.932(50)	-0.003	KHARK
5	1	4	-	4	2	3	-	68026.824(20)	-0.002	KHARK
6	1	5	-	5	2	4	-	78956.473(20)	0.002	KHARK
7	1	6	-	6	2	5	-	89653.277(20)	0.003	KHARK
8	1	7	-	7	2	6	-	100306.540(20)	0.007	KHARK
9	1	8	-	8	2	7	-	110954.123(50)	0.016	KHARK
11	1	10	-	10	2	9	-	132249.620(50)	0.037	DEM82
12	1	11	-	11	2	10	-	142897.668(20)	0.006	KHARK
13	1	12	-	12	2	11	-	153545.700(50)	-0.005	DEM82
18	1	17	-	17	2	16	-	206782.030(50)	0.020	DEM82
19	1	18	-	18	2	17	-	217428.120(50)	0.012	DEM82
20	1	19	-	19	2	18	-	228073.690(50)	-0.044	DEM82
21	1	20	-	20	2	19	-	238718.930(100)	0.071	LILLE
25	1	24	-	24	2	23	-	281293.930(50)	0.088	DEM82
26	1	25	-	25	2	24	-	291936.100(50)	0.012	DEM82
27	1	26	-	26	2	25	-	302577.544(50)	-0.146	NIST
3	3	0	-	2	1	1	-	73149.677(20)	0.023	KHARK
7	3	5	+	7	1	6	-	54631.899(50)	-0.013	KHARK
8	3	6	+	8	1	7	-	64701.705(20)	-0.001	KHARK
9	3	7	+	9	1	8	-	74784.176(50)	-0.050	KHARK
10	3	8	+	10	1	9	-	84857.831(20)	-0.002	KHARK
11	3	9	+	11	1	10	-	94921.873(50)	-0.040	KHARK
12	3	10	+	12	1	11	-	104978.377(20)	-0.033	KHARK
13	3	11	+	13	1	12	-	115028.866(20)	-0.001	KHARK
14	3	12	+	14	1	13	-	125074.286(20)	-0.002	KHARK
15	3	13	+	15	1	14	-	135115.310(20)	-0.004	KHARK
16	3	14	+	16	1	15	-	145152.380(50)	0.025	DEM82
17	3	15	+	17	1	16	-	155185.720(100)	0.045	LILLE
23	3	21	+	23	1	22	-	215313.000(50)	0.017	DEM82
4	4	1	-	3	1	2	-	112181.156(20)	-0.043	KHARK
5	4	2	-	4	1	3	-	133427.588(20)	-0.010	KHARK
4	2	3	-	3	2	2	-	56826.731(50)	-0.014	KHARK
5	2	4	-	4	2	3	-	68153.142(20)	0.001	KHARK

6	2	5 -	5	2	4 -	78977.448(20)	0.002	KHARK
7	2	6 -	6	2	5 -	89656.432(20)	0.003	KHARK
8	2	7 -	7	2	6 -	100306.985(20)	0.008	KHARK
9	2	8 -	8	2	7 -	110954.123(50)	-0.044	KHARK
10	2	9 -	9	2	8 -	121601.693(50)	0.025	KHARK
12	2	11 -	11	2	10 -	142897.668(20)	0.006	KHARK
13	2	12 -	12	2	11 -	153545.700(50)	-0.005	DEM82
18	2	17 -	17	2	16 -	206782.030(50)	0.020	DEM82
19	2	18 -	18	2	17 -	217428.120(50)	0.012	DEM82
20	2	19 -	19	2	18 -	228073.690(50)	-0.044	DEM82
21	2	20 -	20	2	19 -	238718.930(100)	0.071	LILLE
25	2	24 -	24	2	23 -	281293.930(50)	0.088	DEM82
26	2	25 -	25	2	24 -	291936.100(50)	0.012	DEM82
27	2	26 -	26	2	25 -	302577.544(50)	-0.146	NIST
3	2	1 +	3	2	2 -	9944.029(4)	0.001	NIST
4	2	2 +	4	2	3 -	20816.635(4)	0.001	NIST
8	2	6 +	8	2	7 -	64679.979(20)	0.010	KHARK
9	2	7 +	9	2	8 -	74780.780(50)	0.049	KHARK
10	2	8 +	10	2	9 -	84857.317(20)	0.012	KHARK
11	2	9 +	11	2	10 -	94921.873(50)	0.035	KHARK
12	2	10 +	12	2	11 -	104978.377(20)	-0.023	KHARK
13	2	11 +	13	2	12 -	115028.866(20)	0.001	KHARK
14	2	12 +	14	2	13 -	125074.286(20)	-0.002	KHARK
15	2	13 +	15	2	14 -	135115.310(20)	-0.004	KHARK
16	2	14 +	16	2	15 -	145152.380(50)	0.025	DEM82
17	2	15 +	17	2	16 -	155185.720(100)	0.045	LILLE
23	2	21 +	23	2	22 -	215313.000(50)	0.017	DEM82
3	3	0 -	2	2	1 -	67338.920(20)	-0.004	KHARK
4	3	1 -	3	2	2 -	91024.627(20)	0.006	KHARK
6	3	3 -	5	2	4 -	153581.040(100)	0.002	LILLE
4	3	2 +	4	2	3 -	27159.203(4)	0.003	NIST
5	3	3 +	5	2	4 -	35236.120(50)	0.078	VAN81
7	3	5 +	7	2	6 -	54628.759(20)	0.002	KHARK
8	3	6 +	8	2	7 -	64701.262(20)	0.000	KHARK
9	3	7 +	9	2	8 -	74784.176(50)	0.009	KHARK
10	3	8 +	10	2	9 -	84857.831(20)	0.006	KHARK
11	3	9 +	11	2	10 -	94921.873(50)	-0.039	KHARK
12	3	10 +	12	2	11 -	104978.377(20)	-0.033	KHARK
13	3	11 +	13	2	12 -	115028.866(20)	-0.001	KHARK
14	3	12 +	14	2	13 -	125074.286(20)	-0.002	KHARK
15	3	13 +	15	2	14 -	135115.310(20)	-0.004	KHARK
16	3	14 +	16	2	15 -	145152.380(50)	0.025	DEM82
17	3	15 +	17	2	16 -	155185.720(100)	0.045	LILLE
23	3	21 +	23	2	22 -	215313.000(50)	0.017	DEM82
3	2	1 +	2	2	0 +	51605.515(20)	0.000	KHARK
4	2	2 +	3	2	1 +	67699.351(20)	0.001	KHARK
5	2	3 +	4	2	2 +	80233.952(20)	0.002	KHARK
6	2	4 +	5	2	3 +	90162.278(20)	0.004	KHARK
7	2	5 +	6	2	4 +	100082.430(20)	0.010	KHARK
8	2	6 +	7	2	5 +	110478.685(20)	0.001	KHARK
9	2	7 +	8	2	6 +	121054.931(20)	0.002	KHARK
10	2	8 +	9	2	7 +	131678.243(20)	0.001	KHARK
11	2	9 +	10	2	8 +	142314.172(50)	0.056	KHARK
12	2	10 +	11	2	9 +	152954.190(50)	-0.034	DEM82
17	2	15 +	16	2	14 +	206168.760(50)	-0.030	DEM82
18	2	16 +	17	2	15 +	216811.750(50)	-0.023	DEM82
19	2	17 +	18	2	16 +	227454.460(50)	0.046	DEM82
20	2	18 +	19	2	17 +	238096.710(100)	0.075	LILLE
24	2	22 +	23	2	21 +	280660.250(50)	0.038	DEM82
25	2	23 +	24	2	22 +	291299.550(50)	-0.016	DEM82
26	2	24 +	25	2	23 +	301938.101(50)	-0.134	NIST
3	3	1 +	2	2	0 +	63124.660(20)	0.004	KHARK
4	3	2 +	3	2	1 +	74041.920(20)	0.004	KHARK
5	3	3 +	4	2	2 +	82572.549(20)	0.000	KHARK
6	3	4 +	5	2	3 +	90757.204(20)	0.007	KHARK
7	3	5 +	6	2	4 +	100202.920(20)	0.005	KHARK
8	3	6 +	7	2	5 +	110500.001(50)	0.025	NIST
9	3	7 +	8	2	6 +	121058.361(20)	-0.004	KHARK
10	3	8 +	9	2	7 +	131678.763(20)	0.001	KHARK
11	3	9 +	10	2	8 +	142314.172(50)	-0.019	KHARK
12	3	10 +	11	2	9 +	152954.190(50)	-0.044	DEM82
17	3	15 +	16	2	14 +	206168.760(50)	-0.030	DEM82
18	3	16 +	17	2	15 +	216811.750(50)	-0.023	DEM82
19	3	17 +	18	2	16 +	227454.460(50)	0.046	DEM82
20	3	18 +	19	2	17 +	238096.710(100)	0.075	LILLE
24	3	22 +	23	2	21 +	280660.250(50)	0.038	DEM82
25	3	23 +	24	2	22 +	291299.550(50)	-0.016	DEM82
26	3	24 +	25	2	23 +	301938.101(50)	-0.134	NIST
3	3	0 -	3	2	1 +	12983.558(4)	0.013	NIST
4	3	1 -	4	2	2 +	13381.245(4)	0.003	NIST
5	3	2 -	5	2	3 +	19483.576(4)	0.001	NIST
6	3	3 -	6	2	4 +	30521.370(50)	0.049	VAN81
8	3	5 -	8	2	6 +	53661.353(50)	0.003	KHARK
9	3	6 -	9	2	7 +	64082.203(20)	-0.002	KHARK
10	3	7 -	10	2	8 +	74280.694(20)	-0.004	KHARK
11	3	8 -	11	2	9 +	84405.673(50)	0.008	KHARK
12	3	9 -	12	2	10 +	94499.323(20)	-0.005	KHARK
13	3	10 -	13	2	11 +	104574.972(50)	0.014	KHARK
14	3	11 -	14	2	12 +	114638.025(20)	0.004	KHARK
15	3	12 -	15	2	13 +	124691.404(20)	-0.005	KHARK
16	3	13 -	16	2	14 +	134736.877(20)	-0.005	KHARK
17	3	14 -	17	2	15 +	144775.581(20)	-0.005	KHARK
18	3	15 -	18	2	16 +	154808.305(100)	0.014	LILLE
24	3	21 -	24	2	22 +	214899.110(50)	-0.016	DEM82
5	2	3 +	4	3	2 +	73891.392(20)	0.008	KHARK
6	2	4 +	5	3	3 +	87823.675(20)	0.000	KHARK
7	2	5 +	6	3	4 +	99487.502(20)	0.005	KHARK
8	2	6 +	7	3	5 +	110358.189(20)	0.000	KHARK
9	2	7 +	8	3	6 +	121033.638(20)	0.002	KHARK
10	2	8 +	9	3	7 +	131674.808(20)	0.001	KHARK
11	2	9 +	10	3	8 +	142313.624(50)	0.027	KHARK
12	2	10 +	11	3	9 +	152954.190(50)	0.041	DEM82
17	2	15 +	16	3	14 +	206168.760(50)	-0.030	DEM82
18	2	16 +	17	3	15 +	216811.750(50)	-0.023	DEM82
19	2	17 +	18	3	16 +	227454.460(50)	0.046	DEM82
20	2	18 +	19	3	17 +	238096.710(100)	0.075	LILLE
24	2	22 +	23	3	21 +	280660.250(50)	0.038	DEM82
25	2	23 +	24	3	22 +	291299.550(50)	-0.016	DEM82
26	2	24 +	25	3	23 +	301938.101(50)	-0.134	NIST
9	4	6 -	9	2	7 +	64183.345(20)	-0.001	KHARK
10	4	7 -	10	2	8 +	74299.326(20)	0.001	KHARK
11	4	8 -	11	2	9 +	84408.801(50)	-0.023	KHARK
12	4	9 -	12	2	10 +	94499.819(20)	-0.013	KHARK
13	4	10 -	13	2	11 +	104574.972(50)	-0.063	KHARK
14	4	11 -	14	2	12 +	114638.025(20)	-0.008	KHARK
15	4	12 -	15	2	13 +	124691.404(20)	-0.007	KHARK
16	4	13 -	16	2	14 +	134736.877(20)	-0.005	KHARK
17	4	14 -	17	2	15 +	144775.581(20)	-0.005	KHARK
18	4	15 -	18	2	16 +	154808.305(100)	0.014	LILLE
24	4	21 -	24	2	22 +	214899.110(50)	-0.016	DEM82
11	5	7 +	10	2	8 +	300387.835(50)	0.090	NIST
4	3	2 +	3	3	1 +	62522.766(20)	-0.009	KHARK
5	3	3 +	4	3	2 +	76229.987(20)	0.004	KHARK
6	3	4 +	5	3	3 +	88418.595(20)	-0.003	KHARK
7	3	5 +	6	3	4 +	99607.997(20)	0.005	KHARK
8	3	6 +	7	3	5 +	110379.481(20)	-0.001	KHARK
9	3	7 +	8	3	6 +	121037.076(20)	0.004	KHARK
10	3	8 +	9	3	7 +	131675.328(20)	0.002	KHARK
11	3	9 +	10	3	8 +	142313.624(50)	-0.048	KHARK
12	3	10 +	11	3	9 +	152954.190(50)	0.031	DEM82
17	3	15 +	16	3	14 +	206168.760(50)	-0.030	DEM82
18	3	16 +	17	3	15 +	216811.750(50)	-0.023	DEM82
19	3	17 +	18	3	16 +	227454.460(50)	0.046	DEM82
20	3	18 +	19	3	17 +	238096.710(100)	0.075	LILLE
24	3	22 +	23	3	21 +	280660.250(50)	0.038	DEM82
25	3	23 +	24	3	22 +	291299.550(50)	-0.016	DEM82
26	3	24 +	25	3	23 +	301938.101(50)	-0.134	NIST
5	3	2 -	5	3	3 +	17144.977(4)	0.001	NIST
6	3	3 -	6	3	4 +	29926.570(200)	0.172	KRI71
8	3	5 -	8	3	6 +	53640.054(50)	-0.003	KHARK
9	3	6 -	9	3	7 +	64078.774(20)	0.004	KHARK
10	3	7 -	10	3	8 +	74280.178(20)	0.000	KHARK
11	3	8 -	11	3	9 +	84405.597(50)	0.007	KHARK
12	3	9 -	12	3	10 +	94499.323(20)	0.005	KHARK
13	3	10 -	13	3	11 +	104574.972(50)	0.015	KHARK
14	3	11 -	14	3	12 +	114638.025(20)	0.004	KHARK
15	3	12 -	15	3	13 +	124691.404(20)	-0.005	KHARK
16	3	13 -	16	3	14 +	134736.877(20)	-0.005	KHARK
17	3	14 -	17	3	15 +	144775.581(20)	-0.005	KHARK
18	3	15 -	18	3	16 +	154808.305(100)	0.014	LILLE
24	3	21 -	24	3	22 +	214899.110(50)	-0.016	DEM82
4	4	0 +	3	3	1 +	88919.280(20)	0.007	KHARK
5	4	1 +	4	3	2 +	109914.411(20)	-0.017	KHARK
6	4	2 +	5	3	3 +	137152.739(20)	-0.005	KHARK
4	4	1 -	4	3	2 +	25740.907(4)	0.003	NIST
5	4	2 -	5	3	3 +	29391.570(50)	-0.036	VAN81
6	4	3 -	6	3	4 +	35848.420(50)	-0.023	VAN81
9	4	6 -	9	3	7 +	64179.911(20)	0.000	KHARK
10	4	7 -	10	3	8 +	74298.804(20)	-0.002	KHARK
11	4	8 -	11	3	9 +	84408.732(50)	-0.017	KHARK
12	4	9 -	12	3	10 +	94499.819(20)	-0.002	KHARK
13	4	10 -	13	3	11 +	104574.972(50)	-0.061	KHARK
14	4	11 -	14	3	12 +	114638.025(20)	-0.007	KHARK
15	4	12 -	15	3	13 +	124691.404(20)	-0.007	KHARK
16	4	13 -	16	3	14 +	134736.877(20)	-0.005	KHARK
17	4	14 -	17	3	15 +	144775.581(20)	-0.005	KHARK
18	4	15 -	18	3	16 +	154808.305(100)	0.014	LILLE
24	4	21 -	24	3	22 +	214899.110(50)	-0.016	DEM82
4	3	1 -	3	3	0 -	68097.046(20)	-0.001	KHARK
5	3	2 -	4	3	1 -	86336.280(20)	-0.003	KHARK
7	3	4 -	6	3	3 -	112152.720(20)	-0.001	KHARK
8	3	5 -	7	3	4 -	121548.413(20)	0.000	KHARK
9	3	6 -	8	3	5 -	131475.784(20)	0.000	KHARK
10	3	7 -	9	3	6 -	141876.736(20)	0.001	KHARK
11	3	8 -	10	3	7 -	152439.080(50)	-0.004	DEM82
17	3	14 -	16	3	13 -	216207.500(50)	0.007	DEM82
18	3	15 -	17	3	14 -	226844.490(50)	0.011	DEM82
23	3	20 -	22	3	19 -	280028.240(50)	-0.002	DEM82
24	3	21 -	23	3	20 -	290663.780(50)	0.033	DEM82
25	3	22 -	24	3	21 -	301298.549(50)	-0.083	NIST
30	3	27 -	29	3	26 -	354461.964(50)	0.084	WLO88
4	4	1 -	3	3	0 -	86799.279(20)	0.004	KHARK
5	4	2 -	4	3	1 -	98582.920(20)	0.007	KHARK
6	4	3 -	5	3	2 -	107122.079(20)	0.013	KHARK
7	4	4 -	6	3	3 -	114123.977(20)	0.004	KHARK
8	4	5 -	7	3	4 -	122037.111(20)	0.000	KHARK
9	4	6 -	8	3	5 -	131576.924(20)	-0.001	KHARK
10	4	7 -	9	3	6 -	141895.364(20)	0.002	KHARK
11	4	8 -	10	3	7 -	152442.250(50)	0.007	DEM82
17	4	14 -	16	3	13 -	216207.500(50)	0.007	DEM82
18	4	15 -	17	3	14 -	226844.490(50)	0.011	DEM82
23	4	20 -	22	3	19 -	280028.240(50)	-0.002	DEM82
24	4	21 -	23	3	20 -	290663.780(50)	0.033	DEM82
25	4	22 -	24	3	21 -	301298.549(50)	-0.083	NIST
30	4	27 -	29	3	26 -	354461.964(50)	0.084	WLO88
4	4	0 +	4	3	1 -	19357.838(4)	0.017	NIST
5	4	1 +	5	3	2 -	16539.473(4)	0.004	NIST
6	4	2 +	6	3	3 -	18807.750(4)	0.002	NIST
7	4	3 +	7	3	4 -	27518.940(50)	-0.101	VAN81
8	4	4 +	8	3	5 -	39982.940(50)	-0.023	VAN81
9	4	5 +	9	3	6 -	52164.407(50)	0.004	KHARK
10	4	6 +	10	3	7 -	63162.662(20)	0.002	KHARK
11	4	7 +	11	3	8 -	73588.855(20)	-0.002	KHARK
12	4	8 +	12	3	9 -	83815.147(50)	-0.009	KHARK
13	4	9 +	13	3	10 -	93965.340(20)	-0.018	KHARK
14	4	10 +	14	3	11 -	104077.751(20)	0.004	KHARK
15	4	11 +	15	3	12 -	114166.340(50)	0.033	KHARK
16	4	12 +	16	3	13 -	124237.659(20)	-0.004	KHARK
17	4	13 +	17	3	14 -	134295.630(20)	-0.005	KHARK
18	4	14 +	18	3	15 -	144342.665(20)	-0.008	KHARK
19	4	15 +	19	3	16 -	154380.500(50)	0.070	DEM82
25	4	21 +	25	3	22 -	214458.180(50)	-0.005	DEM82
5	3	2 -	4	4	1 -	67634.024(20)	-0.031	KHARK

[a] Upper and lower state quantum numbers are indicated by ′ and ″, respectively. Torsion–rotation levels of A species, given in the first part of the table, have a ± "parity" label; levels of E species, given in the second part of the table, have a signed K_a value (*30*).

[b] Observed $v_t = 0$ microwave transitions in MHz, with assigned standard uncertainties in kHz in parentheses, except for (990) which actually means (1000).

[c] Observed minus calculated residuals (O − C) in MHz.

[d] Data sources: KHARK, LILLE, NIST = this work; KR171 = Ref. (*5*); WLO88 = Ref. (*6*); VAN81 = Ref. (*8*); DEM82 = Ref. (*9*); VAN83 = Ref. (*10*).

TABLE 3—*Continued*

J'	Ka'	Kc'	P'	J"	Ka"	Kc"	P"	Observed (Unc)	O - C	Source
6	3	3	-	5	4	2	-	88953.394(20)	0.004	KHARK
7	3	4	-	6	4	3	-	106230.685(20)	0.010	KHARK
8	3	5	-	7	4	4	-	119577.162(20)	0.002	KHARK
9	3	6	-	8	4	5	-	130987.086(20)	0.000	KHARK
10	3	7	-	9	4	6	-	141775.596(20)	0.002	KHARK
11	3	8	-	10	4	7	-	152420.460(50)	0.003	DEM82
17	3	14	-	16	4	13	-	216207.500(50)	0.007	DEM82
18	3	15	-	17	4	14	-	226844.490(50)	0.011	DEM82
23	3	20	-	22	4	19	-	280028.240(50)	-0.002	DEM82
24	3	21	-	23	4	20	-	290663.780(50)	0.033	DEM82
25	3	22	-	24	4	21	-	301298.549(50)	-0.083	NIST
30	3	27	-	29	4	26	-	354461.964(50)	0.084	WLO88
9	5	5	+	9	3	6	-	53712.524(50)	0.001	KHARK
10	5	6	+	10	3	7	-	63539.429(20)	-0.003	KHARK
11	5	7	+	11	3	8	-	73667.968(20)	0.004	KHARK
12	5	8	+	12	3	9	-	83830.181(50)	0.018	KHARK
13	5	9	+	13	3	10	-	93967.939(50)	-0.061	KHARK
14	5	10	+	14	3	11	-	104078.184(20)	-0.002	KHARK
15	5	11	+	15	3	12	-	114166.340(50)	-0.037	KHARK
16	5	12	+	16	3	13	-	124237.659(20)	-0.014	KHARK
17	5	13	+	17	3	14	-	134295.630(20)	-0.007	KHARK
18	5	14	+	18	3	15	-	144342.665(20)	-0.009	KHARK
19	5	15	+	19	3	16	-	154380.500(50)	0.070	DEM82
25	5	21	+	25	3	22	-	214458.180(50)	-0.005	DEM82
5	4	2	-	4	4	1	-	79880.682(20)	-0.003	KHARK
6	4	3	-	5	4	2	-	94875.436(20)	0.001	KHARK
7	4	4	-	6	4	3	-	108201.932(20)	0.004	KHARK
8	4	5	-	7	4	4	-	120065.860(20)	0.002	KHARK
9	4	6	-	8	4	5	-	131088.229(20)	0.002	KHARK
10	4	7	-	9	4	6	-	141794.222(20)	0.001	KHARK
11	4	8	-	10	4	7	-	152423.590(50)	-0.025	DEM82
17	4	14	-	16	4	13	-	216207.500(50)	0.007	DEM82
18	4	15	-	17	4	14	-	226844.490(50)	0.011	DEM82
23	4	20	-	22	4	19	-	280028.240(50)	-0.002	DEM82
24	4	21	-	23	4	20	-	290663.780(50)	0.033	DEM82
25	4	22	-	24	4	21	-	301298.549(50)	-0.083	NIST
30	4	27	-	29	4	26	-	354461.964(50)	0.084	WLO88
6	4	2	+	6	4	3	-	12885.702(4)	-0.001	NIST
8	4	4	+	8	4	5	-	39494.260(50)	-0.005	VAN81
9	4	5	+	9	4	6	-	52063.217(50)	-0.045	KHARK
10	4	6	+	10	4	7	-	63144.030(20)	-0.002	KHARK
11	4	7	+	11	4	8	-	73585.695(50)	-0.004	KHARK
13	4	9	+	13	4	10	-	93965.340(50)	0.058	KHARK
14	4	10	+	14	4	11	-	104077.751(20)	0.015	KHARK
15	4	11	+	15	4	12	-	114166.340(50)	0.034	KHARK
16	4	12	+	16	4	13	-	124237.659(20)	-0.004	KHARK
17	4	13	+	17	4	14	-	134295.630(20)	-0.005	KHARK
18	4	14	+	18	4	15	-	144342.665(20)	-0.008	KHARK
19	4	15	+	19	4	16	-	154380.500(50)	0.070	DEM82
25	4	21	+	25	4	22	-	214458.180(50)	-0.005	DEM82
5	5	0	-	4	4	1	-	111097.569(20)	0.001	KHARK
6	5	1	-	5	4	2	-	129843.339(20)	0.002	KHARK
13	5	8	-	12	4	9	-	350679.345(50)	0.062	NIST
5	5	1	+	5	4	2	-	30954.530(50)	-0.108	VAN81
6	5	2	+	6	4	3	-	32721.790(50)	-0.052	VAN81
7	5	3	+	7	4	4	-	37263.900(50)	-0.013	VAN81
10	5	6	+	10	4	7	-	63520.802(20)	-0.003	KHARK
11	5	7	+	11	4	8	-	73664.804(20)	-0.001	KHARK
12	5	8	+	12	4	9	-	83829.657(50)	-0.003	KHARK
13	5	9	+	13	4	10	-	93967.939(50)	0.016	KHARK
14	5	10	+	14	4	11	-	104078.184(20)	0.009	KHARK
15	5	11	+	15	4	12	-	114166.340(50)	-0.035	KHARK
16	5	12	+	16	4	13	-	124237.659(20)	-0.014	KHARK
17	5	13	+	17	4	14	-	134295.630(20)	-0.007	KHARK
18	5	14	+	18	4	15	-	144342.665(20)	-0.009	KHARK
19	5	15	+	19	4	16	-	154380.500(50)	0.070	DEM82
25	5	21	+	25	4	22	-	214458.180(50)	-0.005	DEM82
5	4	1	+	4	4	0	+	83517.914(20)	-0.016	KHARK
6	4	2	+	5	4	1	+	103468.311(20)	0.012	KHARK
7	4	3	+	6	4	2	+	120864.017(20)	0.003	KHARK
8	4	4	+	7	4	3	+	134012.336(20)	0.002	KHARK

J'	Ka'	Kc'	P'	J"	Ka"	Kc"	P"	Observed (Unc)	O - C	Source
9	4	5	+	8	4	4	+	143657.241(20)	0.017	KHARK
10	4	6	+	9	4	5	+	152874.980(50)	-0.011	KHARK
18	4	14	+	17	4	13	+	236891.510(100)	-0.007	LILLE
23	4	19	+	22	4	18	+	290037.560(50)	0.010	DEM82
29	4	25	+	28	4	24	+	353806.584(50)	0.041	NIST
30	4	26	+	29	4	25	+	364432.227(50)	0.051	NIST
5	5	1	+	4	4	0	+	110179.732(20)	0.003	KHARK
6	5	2	+	5	4	1	+	123304.447(20)	0.009	KHARK
7	5	3	+	6	4	2	+	132580.136(20)	-0.002	KHARK
8	5	4	+	7	4	3	+	139043.729(20)	0.003	KHARK
10	5	6	+	9	4	5	+	153251.752(20)	-0.012	KHARK
18	5	14	+	17	4	13	+	236891.510(100)	-0.007	LILLE
23	5	19	+	22	4	18	+	290037.560(50)	0.010	DEM82
29	5	25	+	28	4	24	+	353806.584(50)	0.041	NIST
30	5	26	+	29	4	25	+	364432.227(50)	0.051	NIST
5	5	0	-	5	4	1	+	26923.910(200)	-0.133	KRI71
6	5	1	-	6	4	2	+	22082.205(4)	0.006	NIST
7	5	2	-	7	4	3	+	20357.705(4)	0.003	NIST.
8	5	3	-	8	4	4	+	25240.590(200)	0.008	KRI71
9	5	4	-	9	4	5	+	36411.110(50)	-0.029	VAN81
10	5	5	-	10	4	6	+	49642.270(50)	0.000	KHARK
11	5	6	-	11	4	7	+	61698.939(20)	-0.001	KHARK
13	5	8	-	13	4	9	+	83042.626(20)	-0.001	KHARK
15	5	10	-	15	4	11	+	103469.475(50)	-0.018	KHARK
16	5	11	-	16	4	12	+	113600.731(20)	-0.005	KHARK
17	5	12	-	17	4	13	+	123702.898(20)	0.022	KHARK
18	5	13	-	18	4	14	+	133783.421(20)	-0.005	KHARK
19	5	14	-	19	4	15	+	143846.988(20)	-0.009	KHARK
20	5	15	-	20	4	16	+	153896.640(50)	-0.018	DEM82
26	5	21	-	26	4	22	+	213988.500(50)	0.027	DEM82
6	4	2	+	5	5	1	+	76806.489(50)	-0.011	KHARK
7	4	3	+	6	5	2	+	101027.893(50)	0.019	KHARK
8	4	4	+	7	5	3	+	122296.206(20)	-0.004	KHARK
9	4	5	+	8	5	4	+	138625.834(20)	0.002	KHARK
18	4	14	+	17	5	13	+	236891.510(100)	-0.005	LILLE
23	4	19	+	22	5	18	+	290037.560(50)	0.010	DEM82
29	4	25	+	28	5	24	+	353806.584(50)	0.041	NIST
30	4	26	+	29	5	25	+	364432.227(50)	0.051	NIST
10	6	5	-	10	4	6	+	53644.315(50)	-0.002	KHARK
11	6	6	-	11	4	7	+	62859.588(20)	0.002	KHARK
12	6	7	-	12	4	8	+	72890.710(50)	-0.008	KHARK
13	6	8	-	13	4	9	+	83101.767(20)	0.004	KHARK
15	6	10	-	15	4	11	+	103471.515(50)	-0.057	KHARK
16	6	11	-	16	4	12	+	113601.078(20)	-0.015	KHARK
17	6	12	-	17	4	13	+	123702.898(50)	-0.037	KHARK
18	6	13	-	18	4	14	+	133783.421(20)	-0.014	KHARK
19	6	14	-	19	4	15	+	143846.988(20)	-0.010	KHARK
20	6	15	-	20	4	16	+	153896.640(50)	-0.018	DEM82
26	6	21	-	26	4	22	+	213988.500(50)	0.027	DEM82
6	5	2	+	5	5	1	+	96642.606(20)	-0.033	KHARK
7	5	3	+	6	5	2	+	112743.995(20)	-0.004	KHARK
8	5	4	+	7	5	3	+	127327.572(20)	-0.030	KHARK
9	5	5	+	8	5	4	+	140173.955(20)	0.002	KHARK
18	5	14	+	17	5	13	+	236891.510(100)	-0.005	LILLE
23	5	19	+	22	5	18	+	290037.560(50)	0.010	DEM82
29	5	25	+	28	5	24	+	353806.584(50)	0.041	NIST
30	5	26	+	29	5	25	+	364432.227(50)	0.051	NIST
8	5	3	-	8	5	4	+	20209.130(200)	-0.060	KRI71
9	5	4	-	9	5	5	+	34863.010(50)	-0.008	VAN81
10	5	5	-	10	5	6	+	49265.512(50)	0.014	KHARK
11	5	6	-	11	5	7	+	61619.835(20)	0.002	KHARK
13	5	8	-	13	5	9	+	83039.988(20)	0.002	KHARK
15	5	10	-	15	5	11	+	103469.475(50)	0.052	KHARK
16	5	11	-	16	5	12	+	113600.731(20)	0.005	KHARK
17	5	12	-	17	5	13	+	123702.898(50)	0.023	KHARK
18	5	13	-	18	5	14	+	133783.421(20)	-0.004	KHARK
19	5	14	-	19	5	15	+	143846.988(20)	-0.009	KHARK
20	5	15	-	20	5	16	+	153896.640(50)	-0.018	DEM82
26	5	21	-	26	5	22	+	213988.500(50)	0.027	DEM82
7	6	2	-	7	5	3	+	37127.290(50)	-0.069	VAN81
8	6	3	-	8	5	4	+	39713.110(50)	0.016	VAN81

J'	Ka'	Kc'	P'	J"	Ka"	Kc"	P"	Observed (Unc)	O - C	Source
10	6	5	-	10	5	6	+	53267.544(20)	-0.001	KHARK
11	6	6	-	11	5	7	+	62780.480(20)	0.001	KHARK
13	6	8	-	13	5	9	+	83099.120(20)	-0.001	KHARK
15	6	10	-	15	5	11	+	103471.515(50)	0.013	KHARK
16	6	11	-	16	5	12	+	113601.078(20)	-0.005	KHARK
17	6	12	-	17	5	13	+	123702.898(50)	-0.035	KHARK
18	6	13	-	18	5	14	+	133783.421(20)	-0.014	KHARK
19	6	14	-	19	5	15	+	143846.988(20)	-0.010	KHARK
20	6	15	-	20	5	16	+	153896.640(50)	-0.018	DEM82
26	6	21	-	26	5	22	+	213988.500(50)	0.027	DEM82
6	5	1	-	5	5	0	-	98626.454(20)	0.000	KHARK
7	5	2	-	6	5	1	-	119139.513(20)	-0.004	KHARK
8	5	3	-	7	5	2	-	138895.211(20)	-0.004	KHARK
9	5	4	-	8	5	3	-	154827.800(50)	0.019	DEM82
22	5	17	-	21	5	16	-	289435.480(50)	0.069	DEM82
23	5	18	-	22	5	17	-	300056.125(50)	0.092	NIST
28	5	23	-	27	5	22	-	353161.785(50)	0.050	WLO88
29	5	24	-	28	5	23	-	363781.845(50)	0.069	NIST
6	6	1	-	5	5	0	-	133251.589(20)	0.001	KHARK
7	6	2	-	6	5	1	-	147625.300(20)	0.002	KHARK
22	6	17	-	21	5	16	-	289435.480(50)	0.069	DEM82
23	6	18	-	22	5	17	-	300056.125(50)	0.092	NIST
28	6	23	-	27	5	22	-	353161.785(50)	0.050	WLO88
29	6	24	-	28	5	23	-	363781.845(50)	0.069	NIST
6	6	0	+	6	5	1	-	34722.940(50)	-0.014	VAN81
7	6	1	+	7	5	2	-	29522.530(50)	0.017	VAN81
8	6	2	+	8	5	3	-	24587.330(4)	0.004	NIST
9	6	3	+	9	5	4	-	24949.230(200)	-0.015	KRI71
10	6	4	+	10	5	5	-	32832.620(50)	0.057	VAN81
12	6	6	+	12	5	7	-	59344.613(50)	0.011	KHARK
13	6	7	+	13	5	8	-	71179.347(20)	-0.002	KHARK
14	6	8	+	14	5	9	-	82015.735(20)	0.003	KHARK
15	6	9	+	15	5	10	-	92452.222(20)	0.000	KHARK
16	6	10	+	16	5	11	-	102728.392(20)	0.003	KHARK
17	6	11	+	17	5	12	-	112925.853(50)	-0.016	KHARK
18	6	12	+	18	5	13	-	123075.289(20)	-0.006	KHARK
19	6	13	+	19	5	14	-	133190.994(50)	0.015	KHARK
20	6	14	+	20	5	15	-	143281.083(20)	-0.007	KHARK
21	6	15	+	21	5	16	-	153350.830(50)	-0.052	DEM82
27	6	21	+	27	5	22	-	213488.020(50)	0.031	DEM82
8	5	3	-	7	6	2	-	110409.421(20)	-0.012	KHARK
9	5	4	-	8	6	3	-	135323.882(20)	0.005	KHARK
10	5	5	-	9	6	4	-	155734.240(100)	0.167	LILLE
22	5	17	-	21	6	16	-	289435.480(50)	0.069	DEM82
23	5	18	-	22	6	17	-	300056.125(50)	0.092	NIST
28	5	23	-	27	6	22	-	353161.785(50)	0.050	WLO88
29	5	24	-	28	6	23	-	363781.845(50)	0.068	NIST
14	7	7	-	13	5	8	-	355685.554(50)	-0.091	NIST
9	7	3	+	9	5	4	-	53660.399(50)	0.024	KHARK
10	7	4	+	10	5	5	-	50861.815(50)	-0.015	KHARK
11	7	5	+	11	5	6	-	54536.802(20)	-0.006	KHARK
12	7	6	+	12	5	7	-	62377.915(20)	0.005	KHARK
14	7	8	+	14	5	9	-	82216.004(20)	0.001	KHARK
15	7	9	+	15	5	10	-	92495.040(20)	-0.004	KHARK
16	7	10	+	16	5	11	-	102736.838(20)	-0.006	KHARK
17	7	11	+	17	5	12	-	112927.386(50)	-0.052	KHARK
18	7	12	+	18	5	13	-	123075.559(20)	-0.013	KHARK
19	7	13	+	19	5	14	-	133190.994(50)	-0.032	KHARK
20	7	14	+	20	5	15	-	143281.083(20)	-0.015	KHARK
21	7	15	+	21	5	16	-	153350.830(50)	-0.053	DEM82
27	7	21	+	27	5	22	-	213488.020(50)	0.031	DEM82
7	6	2	-	6	6	1	-	113000.167(20)	0.003	KHARK
8	6	3	-	7	6	2	-	129913.334(20)	-0.003	KHARK
9	6	4	-	8	6	3	-	145695.933(20)	0.005	KHARK
22	6	17	-	21	6	16	-	289435.480(50)	0.069	DEM82
23	6	18	-	22	6	17	-	300056.125(50)	0.092	NIST
28	6	23	-	27	6	22	-	353161.785(50)	0.050	WLO88
29	6	24	-	28	6	23	-	363781.845(50)	0.069	NIST
9	6	3	+	9	6	4	-	14577.350(200)	0.155	KRI71
12	6	6	+	12	6	7	-	59065.863(20)	0.015	KHARK
13	6	7	+	13	6	8	-	71120.225(50)	0.011	KHARK

14	6	8	+	14	6	9	-	82004.261(20)	0.002	KHARK
15	6	9	+	15	6	10	-	92450.150(20)	0.007	KHARK
16	6	10	+	16	6	11	-	102728.022(20)	-0.010	KHARK
17	6	11	+	17	6	12	-	112925.853(50)	0.043	KHARK
18	6	12	+	18	6	13	-	123075.289(20)	0.003	KHARK
19	6	13	+	19	6	14	-	133190.994(50)	0.016	KHARK
20	6	14	+	20	6	15	-	143281.083(20)	-0.007	KHARK
21	6	15	+	21	6	16	-	153350.830(50)	-0.052	DEM82
27	6	21	+	27	6	22	-	213488.020(50)	0.031	DEM82
7	7	0	-	6	6	1	-	156272.260(100)	0.111	LILLE
14	7	7	-	13	6	8	-	355626.557(50)	0.047	NIST
11	7	5	+	11	6	6	-	53376.160(50)	-0.001	KHARK
12	7	6	+	12	6	7	-	62099.155(20)	-0.002	KHARK
14	7	8	+	14	6	9	-	82204.534(20)	0.003	KHARK
15	7	9	+	15	6	10	-	92492.964(20)	-0.001	KHARK
16	7	10	+	16	6	11	-	102736.493(20)	0.006	KHARK
17	7	11	+	17	6	12	-	112927.386(50)	0.007	KHARK
18	7	12	+	18	6	13	-	123075.559(20)	-0.004	KHARK
19	7	13	+	19	6	14	-	133190.994(50)	-0.031	KHARK
20	7	14	+	20	6	15	-	143281.083(20)	-0.014	KHARK
21	7	15	+	21	6	16	-	153350.830(50)	-0.053	DEM82
27	7	21	+	27	6	22	-	213488.020(50)	0.031	DEM82
7	6	1	+	6	6	0	+	113939.073(20)	-0.002	KHARK
8	6	2	+	7	6	1	+	133960.027(20)	-0.001	KHARK
9	6	3	+	8	6	2	+	155189.730(100)	0.029	LILLE
16	6	10	+	15	6	9	+	236049.930(100)	0.124	LILLE
27	6	21	+	26	6	20	+	352537.969(50)	0.024	WLO88
28	6	22	+	27	6	21	+	363150.170(50)	0.021	NIST
16	7	10	+	15	6	9	+	236058.320(100)	0.059	LILLE
27	7	21	+	26	6	20	+	352537.969(50)	0.024	WLO88
28	7	22	+	27	6	21	+	363150.170(50)	0.021	NIST
8	7	1	-	8	6	2	+	37802.830(50)	0.025	VAN81
9	7	2	-	9	6	3	+	31347.250(50)	-0.015	VAN81
10	7	3	-	10	6	4	+	27444.940(50)	-0.011	VAN81
11	7	4	-	11	6	5	+	30675.950(50)	-0.006	VAN81
13	7	6	-	13	6	7	+	55761.941(20)	0.006	KHARK
14	7	7	-	14	6	8	+	69003.213(20)	0.004	KHARK
15	7	8	-	15	6	9	+	80604.948(20)	0.007	KHARK
16	7	9	-	16	6	10	+	91380.621(20)	0.003	KHARK
17	7	10	-	17	6	11	+	101824.585(20)	0.005	KHARK
18	7	11	-	18	6	12	+	112122.553(20)	-0.004	KHARK
19	7	12	-	19	6	13	+	122341.018(50)	-0.015	KHARK
20	7	13	-	20	6	14	+	132507.587(20)	-0.008	KHARK
21	7	14	-	21	6	15	+	142636.452(50)	0.008	KHARK
22	7	15	-	22	6	16	+	152736.210(50)	0.002	DEM82
28	7	21	-	28	6	22	+	212954.320(50)	-0.040	DEM82
8	6	2	+	7	7	1	+	91759.672(50)	0.041	KHARK
9	6	3	+	8	7	2	+	117825.125(50)	0.002	KHARK
16	6	10	+	15	7	9	+	236006.990(50)	0.006	DEM82
27	6	21	+	26	7	20	+	352537.969(50)	0.024	WLO88
28	6	22	+	27	7	21	+	363150.170(50)	0.021	NIST
9	8	2	-	9	6	3	+	77152.087(50)	-0.003	KHARK
10	8	3	-	10	6	4	+	65955.264(50)	-0.005	KHARK
13	8	6	-	13	6	7	+	62552.843(20)	-0.011	KHARK
14	8	7	-	14	6	8	+	71220.871(50)	0.001	KHARK
15	8	8	-	15	6	9	+	81200.840(50)	0.007	KHARK
16	8	9	-	16	6	10	+	91521.339(20)	0.000	KHARK
17	8	10	-	17	6	11	+	101854.870(20)	0.012	KHARK
18	8	11	-	18	6	12	+	112128.623(20)	0.002	KHARK
19	8	12	-	19	6	13	+	122342.134(50)	-0.046	KHARK
20	8	13	-	20	6	14	+	132507.796(20)	-0.007	KHARK
21	8	14	-	21	6	15	+	142636.452(50)	-0.028	KHARK
22	8	15	-	22	6	16	+	152736.210(50)	-0.004	DEM82
28	8	21	-	28	6	22	+	212954.320(50)	-0.040	DEM82
16	7	10	+	15	7	9	+	236015.420(50)	-0.019	DEM82
27	7	21	+	26	7	20	+	352537.969(50)	0.024	WLO88
28	7	22	+	27	7	21	+	363150.170(50)	0.021	NIST
11	7	4	-	11	7	5	+	22057.880(200)	-0.037	KRI71
13	7	6	-	13	7	7	+	54919.990(50)	0.024	KHARK
14	7	7	-	14	7	8	+	68802.941(50)	0.004	KHARK
15	7	8	-	15	7	9	+	80562.063(50)	-0.056	KHARK

16	7	9	-	16	7	10	+	91372.168(20)	0.005	KHARK
17	7	10	-	17	7	11	+	101823.018(20)	0.006	KHARK
18	7	11	-	18	7	12	+	112122.279(20)	-0.001	KHARK
19	7	12	-	19	7	13	+	122341.018(50)	0.032	KHARK
20	7	13	-	20	7	14	+	132507.587(20)	-0.001	KHARK
21	7	14	-	21	7	15	+	142636.452(50)	0.009	KHARK
22	7	15	-	22	7	16	+	152736.210(50)	0.002	DEM82
28	7	21	-	28	7	22	+	212954.320(50)	-0.040	DEM82
8	8	1	-	8	7	2	+	49843.739(50)	0.006	KHARK
11	8	4	-	11	7	5	+	49588.587(50)	-0.004	KHARK
13	8	6	-	13	7	7	+	61710.882(20)	-0.002	KHARK
14	8	7	-	14	7	8	+	71020.595(20)	-0.003	KHARK
15	8	8	-	15	7	9	+	81158.014(20)	0.003	KHARK
16	8	9	-	16	7	10	+	91512.884(20)	0.000	KHARK
17	8	10	-	17	7	11	+	101853.294(20)	0.004	KHARK
18	8	11	-	18	7	12	+	112128.342(20)	-0.002	KHARK
19	8	12	-	19	7	13	+	122342.134(50)	0.001	KHARK
20	8	13	-	20	7	14	+	132507.796(20)	0.001	KHARK
21	8	14	-	21	7	15	+	142636.452(50)	-0.027	KHARK
22	8	15	-	22	7	16	+	152736.210(50)	-0.004	DEM82
28	8	21	-	28	7	22	+	212954.320(50)	-0.040	DEM82
15	7	8	-	14	7	7	-	237237.120(100)	0.090	LILLE
26	7	19	-	25	7	18	-	351952.594(50)	0.020	WLO88
27	7	20	-	26	7	19	-	362552.139(50)	0.043	NIST
26	8	19	-	25	7	18	-	351952.594(50)	0.020	WLO88
27	8	20	-	26	7	19	-	362552.139(50)	0.043	NIST
8	8	0	+	8	7	1	-	49417.545(50)	0.008	KHARK
10	8	2	+	10	7	3	-	39746.860(50)	0.028	VAN81
11	8	3	+	11	7	4	-	32931.540(50)	-0.034	VAN81
12	8	4	+	12	7	5	-	31143.750(50)	0.014	VAN81
13	8	5	+	13	7	6	-	37726.120(50)	-0.003	VAN81
14	8	6	+	14	7	7	-	51036.328(50)	0.012	KHARK
15	8	7	+	15	7	8	-	65707.632(20)	0.014	KHARK
16	8	8	+	16	7	9	-	78583.818(20)	0.008	KHARK
17	8	9	+	17	7	10	-	89981.741(20)	0.005	KHARK
18	8	10	+	18	7	11	-	100712.794(20)	0.003	KHARK
19	8	11	+	19	7	12	-	111165.420(20)	-0.003	KHARK
20	8	12	+	20	7	13	-	121483.107(20)	-0.003	KHARK
21	8	13	+	21	7	14	-	131720.673(50)	-0.018	KHARK
22	8	14	+	22	7	15	-	141903.239(20)	-0.006	KHARK
23	8	15	+	23	7	16	-	152044.756(50)	-0.008	KHARK
29	8	21	+	29	7	22	-	212384.830(50)	0.032	DEM82
10	7	3	-	9	8	2	-	124282.280(20)	-0.021	KHARK
26	7	19	-	25	8	18	-	351952.594(50)	0.020	WLO88
27	7	20	-	26	8	19	-	362552.139(50)	0.043	NIST
13	9	5	+	13	7	6	-	62928.606(50)	-0.008	KHARK
14	9	6	+	14	7	7	-	64132.073(50)	-0.014	KHARK
15	9	7	+	15	7	8	-	70830.628(50)	-0.001	KHARK
16	9	8	+	16	7	9	-	80161.255(20)	0.004	KHARK
17	9	9	+	17	7	10	-	90395.392(20)	0.009	KHARK
18	9	10	+	18	7	11	-	100809.934(20)	-0.005	KHARK
19	9	11	+	19	7	12	-	111186.430(20)	-0.004	KHARK
20	9	12	+	20	7	13	-	121487.365(20)	-0.004	KHARK
21	9	13	+	21	7	14	-	131721.474(50)	-0.036	KHARK
22	9	14	+	22	7	15	-	141903.387(20)	-0.009	KHARK
23	9	15	+	23	7	16	-	152044.756(50)	-0.035	KHARK
29	9	21	+	29	7	22	-	212384.830(50)	0.032	DEM82
14	10	5	-	13	7	6	-	352063.836(50)	-0.020	NIST
15	8	8	-	14	8	7	-	235615.310(100)	0.048	LILLE
26	8	19	-	25	8	18	-	351952.594(50)	0.020	WLO88
27	8	20	-	26	8	19	-	362552.139(50)	0.043	NIST
15	8	7	+	15	8	8	-	65111.742(20)	0.016	KHARK
16	8	8	+	16	8	9	-	78443.091(20)	0.002	KHARK
17	8	9	+	17	8	10	-	89951.464(20)	0.006	KHARK
18	8	10	+	18	8	11	-	100706.738(20)	0.011	KHARK
19	8	11	+	19	8	12	-	111164.269(20)	-0.007	KHARK
20	8	12	+	20	8	13	-	121482.896(20)	-0.007	KHARK
21	8	13	+	21	8	14	-	131720.673(50)	0.018	KHARK
22	8	14	+	22	8	15	-	141903.239(20)	0.000	KHARK
23	8	15	+	23	8	16	-	152044.756(50)	-0.007	KHARK
29	8	21	+	29	8	22	-	212384.830(50)	0.032	DEM82

11	9	2	-	10	8	3	-	234234.810(100)	0.039	LILLE
9	9	1	+	9	8	2	-	56553.020(50)	0.006	KHARK
10	9	2	+	10	8	3	-	54855.687(20)	-0.001	KHARK
11	9	3	+	11	8	4	-	53435.631(20)	0.000	KHARK
12	9	4	+	12	8	5	-	53461.643(20)	-0.005	KHARK
13	9	5	+	13	8	6	-	56137.690(20)	-0.006	KHARK
14	9	6	+	14	8	7	-	61914.422(20)	-0.004	KHARK
15	9	7	+	15	8	8	-	70234.735(20)	-0.002	KHARK
16	9	8	+	16	8	9	-	80020.531(20)	0.001	KHARK
17	9	9	+	17	8	10	-	90365.108(20)	0.003	KHARK
18	9	10	+	18	8	11	-	100803.894(20)	0.019	KHARK
19	9	11	+	19	8	12	-	111185.284(20)	-0.003	KHARK
20	9	12	+	20	8	13	-	121487.155(20)	-0.006	KHARK
21	9	13	+	21	8	14	-	131721.474(50)	0.000	KHARK
22	9	14	+	22	8	15	-	141903.387(20)	-0.003	KHARK
23	9	15	+	23	8	16	-	152044.756(50)	-0.034	KHARK
29	9	21	+	29	8	22	-	212384.830(50)	0.032	DEM82
25	8	17	+	24	8	16	+	351438.744(50)	0.056	WLO88
26	8	18	+	25	8	17	+	362014.511(50)	0.017	NIST
19	9	11	+	18	8	10	+	288390.740(50)	-0.042	DEM82
25	9	17	+	24	8	16	+	351438.744(50)	0.055	WLO88
26	9	18	+	25	8	17	+	362014.511(50)	0.017	NIST
9	9	0	-	9	8	1	+	56382.660(20)	0.010	KHARK
10	9	1	-	10	8	2	+	53685.686(50)	0.003	KHARK
13	9	4	-	13	8	5	+	34836.490(50)	0.044	VAN81
14	9	5	-	14	8	6	+	36065.350(50)	-0.037	VAN81
16	9	7	-	16	8	8	+	61076.880(20)	0.015	KHARK
17	9	8	-	17	8	9	+	75608.932(20)	0.013	KHARK
18	9	9	-	18	8	10	+	88082.472(20)	0.007	KHARK
19	9	10	-	19	8	11	+	99317.812(20)	0.008	KHARK
20	9	11	-	20	8	12	+	110017.715(20)	-0.003	KHARK
21	9	12	-	21	8	13	+	120479.639(20)	0.005	KHARK
22	9	13	-	22	8	14	+	130815.051(20)	-0.008	KHARK
23	9	14	-	23	8	15	+	141069.984(50)	-0.012	KHARK
24	9	15	-	24	8	16	+	151267.499(50)	0.030	KHARK
30	9	21	-	30	8	22	+	211775.950(50)	-0.095	DEM82
12	8	4	+	11	9	3	+	158627.140(100)	0.125	LILLE
15	8	7	+	14	9	6	+	238812.670(100)	0.108	LILLE
19	8	11	+	18	9	10	+	288272.670(50)	0.047	DEM82
25	8	17	+	24	9	16	+	351438.744(50)	0.060	WLO88
26	8	18	+	25	9	17	+	362014.511(50)	0.018	NIST
16	10	6	+	15	8	7	+	363227.040(50)	-0.025	NIST
12	10	3	-	12	8	4	+	97649.792(50)	-0.037	KHARK
13	10	4	-	13	8	5	+	83571.160(50)	-0.008	KHARK
15	10	6	-	15	8	7	+	68130.223(20)	-0.016	KHARK
16	10	7	-	16	8	8	+	71448.152(20)	-0.013	KHARK
17	10	8	-	17	8	9	+	79341.028(20)	0.000	KHARK
18	10	9	-	18	8	10	+	89180.745(20)	0.005	KHARK
20	10	11	-	20	8	12	+	110083.854(50)	0.032	KHARK
21	10	12	-	21	8	13	+	120493.991(20)	-0.003	KHARK
22	10	13	-	22	8	14	+	130818.037(20)	0.038	KHARK
23	10	14	-	23	8	15	+	141070.539(50)	-0.031	KHARK
30	10	21	-	30	8	22	+	211775.950(50)	-0.095	DEM82
19	9	11	+	18	9	10	+	288293.590(50)	-0.044	DEM82
25	9	17	+	24	9	16	+	351438.744(50)	0.059	WLO88
26	9	18	+	25	9	17	+	362014.511(50)	0.018	NIST
17	9	8	-	17	9	9	+	75195.288(20)	0.016	KHARK
18	9	9	-	18	9	10	+	87985.330(20)	0.013	KHARK
19	9	10	-	19	9	11	+	99296.803(50)	0.010	KHARK
20	9	11	-	20	9	12	+	110013.461(20)	0.002	KHARK
21	9	12	-	21	9	13	+	120478.826(20)	0.011	KHARK
22	9	13	-	22	9	14	+	130814.873(20)	-0.035	KHARK
23	9	14	-	23	9	15	+	141069.984(50)	0.014	KHARK
24	9	15	-	24	9	16	+	151267.499(50)	0.035	KHARK
30	9	21	-	30	9	22	+	211775.950(50)	-0.095	DEM82
16	10	6	+	15	9	7	+	358104.158(50)	0.104	NIST
10	10	1	-	10	9	2	+	63288.680(20)	0.000	KHARK
11	10	2	-	11	9	3	+	61491.196(20)	0.002	KHARK
12	10	3	-	12	9	4	+	59564.422(20)	-0.016	KHARK
14	10	5	-	14	9	6	+	59187.404(20)	-0.005	KHARK
15	10	6	-	15	9	7	+	63007.220(20)	-0.008	KHARK

TABLE 3—*Continued*

J'	K_a'	K_c'	P'	J"	K_a''	K_c''	P"	Observed (Unc)	O - C	Source
16	10	7	-	16	9	8	+	69870.724(50)	0.000	KHARK
17	10	8	-	17	9	9	+	78927.386(50)	0.004	KHARK
18	10	9	-	18	9	10	+	89083.598(20)	0.006	KHARK
19	10	10	-	19	9	11	+	99579.461(20)	0.007	KHARK
20	10	11	-	20	9	12	+	110079.563(20)	0.000	KHARK
21	10	12	-	21	9	13	+	120493.174(20)	-0.001	KHARK
22	10	13	-	22	9	14	+	130817.848(20)	0.000	KHARK
23	10	14	-	23	9	15	+	141070.539(50)	-0.004	KHARK
24	10	15	-	24	9	16	+	151267.499(50)	-0.072	KHARK
30	10	21	-	30	9	22	+	211775.950(50)	-0.095	DEM82
24	9	15	-	23	9	14	-	351068.019(990)	0.088	NIST
25	9	16	-	24	9	15	-	361592.383(100)	-0.034	NIST
24	10	15	-	23	9	14	-	351068.019(990)	-0.019	NIST
25	10	16	-	24	9	15	-	361592.383(100)	-0.054	NIST
10	10	0	+	10	9	1	-	63223.526(20)	0.012	KHARK
11	10	1	+	11	9	2	-	60976.141(20)	0.005	KHARK
12	10	2	+	12	9	3	-	57005.144(50)	-0.003	KHARK
13	10	3	+	13	9	4	-	50054.071(50)	-0.014	KHARK
15	10	5	+	15	9	6	-	37583.000(50)	0.079	VAN81
17	10	7	+	17	9	8	-	55529.489(20)	0.016	KHARK
18	10	8	+	18	9	9	-	71323.884(20)	0.018	KHARK
19	10	9	+	19	9	10	-	85399.027(20)	0.017	KHARK
20	10	10	+	20	9	11	-	97508.894(20)	0.012	KHARK
21	10	11	+	21	9	12	-	108621.119(20)	0.011	KHARK
22	10	12	+	22	9	13	-	119300.188(20)	0.002	KHARK
23	10	13	+	23	9	14	-	129771.524(20)	-0.002	KHARK
24	10	14	+	24	9	15	-	140122.909(20)	-0.020	KHARK
24	9	15	-	23	10	14	-	351068.019(990)	0.662	NIST
25	9	16	-	24	10	15	-	361592.383(100)	0.073	NIST
16	11	6	+	16	9	7	-	75579.659(20)	-0.036	KHARK
17	11	7	+	17	9	8	-	73966.161(50)	-0.018	KHARK
18	11	8	+	18	9	9	-	79197.854(50)	-0.005	KHARK
19	11	9	+	19	9	10	-	88043.883(20)	0.003	KHARK
20	11	10	+	20	9	11	-	98260.545(20)	0.006	KHARK
21	11	11	+	21	9	12	-	108811.751(20)	0.002	KHARK
22	11	12	+	22	9	13	-	119344.624(20)	0.000	KHARK
23	11	13	+	23	9	14	-	129781.211(20)	-0.006	KHARK
24	10	15	-	23	10	14	-	351068.019(990)	0.554	NIST
25	10	16	-	24	10	15	-	361592.477(100)	0.148	NIST
17	10	7	+	17	10	8	-	51797.398(50)	0.034	KHARK
18	10	8	+	18	10	9	-	70225.615(20)	0.024	KHARK
19	10	9	+	19	10	10	-	85116.361(20)	0.011	KHARK
20	10	10	+	20	10	11	-	97442.792(20)	0.014	KHARK
21	10	11	+	21	10	12	-	108606.750(20)	0.002	KHARK
22	10	12	+	22	10	13	-	119297.250(20)	0.004	KHARK
23	10	13	+	23	10	14	-	129770.956(20)	0.004	KHARK
24	10	14	+	24	10	15	-	140122.672(50)	-0.149	KHARK
11	11	1	+	11	10	2	-	70014.365(50)	0.007	KHARK
12	11	2	+	12	10	3	-	68215.592(20)	0.001	KHARK
13	11	3	+	13	10	4	-	66068.597(20)	-0.005	KHARK
14	11	4	+	14	10	5	-	64091.344(20)	-0.009	KHARK
15	11	5	+	15	10	6	-	63381.347(20)	-0.011	KHARK
16	11	6	+	16	10	7	-	65208.388(20)	-0.007	KHARK
17	11	7	+	17	10	8	-	70234.063(20)	-0.006	KHARK
18	11	8	+	18	10	9	-	78099.585(20)	0.002	KHARK
19	11	9	+	19	10	10	-	87761.223(20)	0.004	KHARK
20	11	10	+	20	10	11	-	98194.443(20)	0.008	KHARK
21	11	11	+	21	10	12	-	108797.397(20)	0.008	KHARK
22	11	12	+	22	10	13	-	119341.685(20)	0.002	KHARK
23	11	13	+	23	10	14	-	129780.640(20)	-0.004	KHARK
24	11	14	+	24	10	15	-	140124.833(50)	0.009	KHARK
23	10	13	+	22	10	12	+	351039.182(50)	-0.011	NIST
24	10	14	+	23	10	13	+	361419.403(50)	0.069	NIST
23	11	13	+	22	10	12	+	351048.700(50)	-0.185	NIST
24	11	14	+	23	10	13	+	361421.276(50)	-0.060	NIST
11	11	0	-	11	10	1	+	69990.241(50)	0.007	KHARK
12	11	1	-	12	10	2	+	68000.818(20)	-0.015	KHARK
13	11	2	-	13	10	3	+	64838.381(20)	-0.003	KHARK
14	11	3	-	14	10	4	+	59259.896(20)	-0.011	KHARK
15	11	4	-	15	10	5	+	50626.609(50)	-0.023	KHARK
19	11	8	-	19	10	9	+	65718.624(20)	0.027	KHARK

J'	K_a'	K_c'	P'	J"	K_a''	K_c''	P"	Observed (Unc)	O - C	Source
20	11	9	-	20	10	10	+	81553.683(20)	0.023	KHARK
22	11	11	-	22	10	12	+	106876.908(20)	0.019	KHARK
23	11	12	-	23	10	13	+	117898.699(20)	0.006	KHARK
24	11	13	-	24	10	14	+	128564.405(20)	0.002	KHARK
25	11	14	-	25	10	15	+	139045.002(20)	-0.004	KHARK
23	10	13	+	22	11	12	+	350994.759(50)	0.003	NIST
24	10	14	+	23	11	13	+	361409.645(50)	0.003	WLO88
23	11	13	+	22	11	12	+	351004.449(50)	0.002	NIST
24	11	14	+	23	11	13	+	361411.638(50)	-0.006	WLO88
19	11	8	-	19	11	9	+	63073.767(20)	0.040	KHARK
20	11	9	-	20	11	10	+	80802.027(20)	0.024	KHARK
21	11	10	-	21	11	11	+	94873.282(20)	0.017	KHARK
22	11	11	-	22	11	12	+	106832.472(20)	0.020	KHARK
23	11	12	-	23	11	13	+	117889.008(20)	0.007	KHARK
24	11	13	-	24	11	14	+	128562.402(20)	0.001	KHARK
25	11	14	-	25	11	15	+	139044.613(20)	0.003	KHARK
14	12	2	+	13	11	3	+	301583.969(50)	0.018	NIST
17	12	5	+	16	11	6	+	355185.812(50)	0.024	NIST
12	12	1	-	12	11	2	+	76714.961(20)	0.007	KHARK
13	12	2	-	13	11	3	+	74955.940(20)	0.000	KHARK
15	12	4	-	15	11	5	+	70371.655(50)	-0.009	KHARK
16	12	5	-	16	11	6	+	68566.427(50)	-0.013	KHARK
17	12	6	-	17	11	7	+	68602.300(20)	-0.011	KHARK
18	12	7	-	18	11	8	+	71599.416(20)	-0.003	KHARK
19	12	8	-	19	11	9	+	77824.679(20)	0.003	KHARK
20	12	9	-	20	11	10	+	86569.915(20)	0.006	KHARK
21	12	10	-	21	11	11	+	96707.221(20)	0.003	KHARK
22	12	11	-	22	11	12	+	107339.708(20)	0.013	KHARK
23	12	12	-	23	11	13	+	118016.167(20)	0.007	KHARK
24	12	13	-	24	11	14	+	128591.973(20)	0.006	KHARK
25	12	14	-	25	11	15	+	139051.077(20)	-0.004	KHARK
22	11	11	-	21	11	10	-	352598.345(50)	0.053	WLO88
23	11	12	-	22	11	11	-	362061.004(50)	0.007	NIST
14	12	3	-	13	11	2	-	301460.233(50)	-0.085	NIST
22	12	11	-	21	11	10	-	353105.527(50)	-0.008	WLO88
23	12	12	-	22	11	11	-	362188.161(50)	0.006	NIST
12	12	0	+	12	11	1	-	76706.251(20)	0.006	KHARK
13	12	1	+	13	11	2	-	74869.927(20)	0.005	KHARK
15	12	3	+	15	11	4	-	67842.222(20)	-0.014	KHARK
16	12	4	+	16	11	5	-	60408.042(50)	-0.016	KHARK
17	12	5	+	17	11	6	-	50695.189(50)	-0.029	KHARK
20	12	8	+	20	11	9	-	59580.756(50)	0.019	KHARK
21	12	9	+	21	11	10	-	76271.873(20)	0.026	KHARK
22	12	10	+	22	11	11	-	91646.680(20)	0.016	KHARK
23	12	11	+	23	11	12	-	104615.980(20)	-0.009	KHARK
24	12	12	+	24	11	13	-	116199.995(20)	0.006	KHARK
25	12	13	+	25	11	14	-	127156.514(20)	0.006	KHARK
26	12	14	+	26	11	15	-	137814.093(20)	0.001	KHARK
27	12	15	+	27	11	16	-	148303.651(20)	-0.002	KHARK
17	11	6	-	16	12	5	-	235924.250(100)	0.121	LILLE
22	11	11	-	21	12	10	-	350764.322(50)	-0.016	NIST
23	11	12	-	22	12	11	-	361553.805(50)	0.052	NIST
22	12	11	-	21	12	10	-	351271.670(50)	0.089	WLO88
23	12	12	-	22	12	11	-	361680.926(50)	0.013	NIST
20	12	8	+	20	12	9	-	53812.878(50)	0.047	KHARK
21	12	9	+	21	12	10	-	74437.927(20)	0.034	KHARK
22	12	10	+	22	12	11	-	91139.447(20)	0.026	KHARK
23	12	11	+	23	12	12	-	104488.821(20)	-0.009	KHARK
24	12	12	+	24	12	13	-	116170.438(20)	0.015	KHARK
25	12	13	+	25	12	14	-	127150.041(20)	0.004	KHARK
26	12	14	+	26	12	15	-	137812.746(20)	0.002	KHARK
27	12	15	+	27	12	16	-	148303.381(20)	-0.003	KHARK
17	13	4	-	16	12	5	-	356467.751(50)	0.021	NIST
13	13	1	+	13	12	2	-	83385.374(20)	0.007	KHARK
14	13	2	+	14	12	3	-	81677.851(20)	-0.001	KHARK
15	13	3	+	15	12	4	-	79518.629(20)	-0.005	KHARK
16	13	4	+	16	12	5	-	76976.207(20)	-0.010	KHARK
18	13	6	+	18	12	7	-	73122.757(20)	-0.012	KHARK
19	13	7	+	19	12	8	-	74140.682(20)	-0.007	KHARK
20	13	8	+	20	12	9	-	78403.562(20)	0.000	KHARK
21	13	9	+	21	12	10	-	85760.888(20)	0.009	KHARK

J'	K_a'	K_c'	P'	J"	K_a''	K_c''	P"	Observed (Unc)	O - C	Source
22	13	10	+	22	12	11	-	95243.010(20)	0.010	KHARK
23	13	11	+	23	12	12	-	105738.545(20)	0.017	KHARK
24	13	12	+	24	12	13	-	116508.730(20)	0.005	KHARK
25	13	13	+	25	12	14	-	127234.054(20)	0.003	KHARK
26	13	14	+	26	12	15	-	137832.240(20)	-0.002	KHARK
27	13	15	+	27	12	16	-	148307.662(20)	-0.005	KHARK
21	12	9	+	20	12	8	+	361027.595(50)	0.016	NIST
17	13	5	+	16	12	4	+	354535.434(50)	0.021	WLO88
13	13	0	-	13	12	1	+	83382.296(20)	0.011	KHARK
14	13	1	-	14	12	2	+	81644.454(20)	0.002	KHARK
15	13	2	-	15	12	3	+	79280.649(20)	-0.008	KHARK
16	13	3	-	16	12	4	+	75750.346(20)	-0.014	KHARK
17	13	4	-	17	12	5	+	69848.359(50)	-0.024	KHARK
18	13	5	-	18	12	6	+	60564.628(20)	-0.029	KHARK
19	13	6	-	19	12	7	+	50812.786(50)	-0.027	KHARK
22	13	9	-	22	12	10	+	69821.711(50)	0.022	KHARK
23	13	10	-	23	12	11	+	86879.011(20)	0.018	KHARK
24	13	11	-	24	12	12	+	101564.736(20)	0.005	KHARK
25	13	12	-	25	12	13	+	114076.745(20)	0.008	KHARK
26	13	13	-	26	12	14	+	125489.709(20)	0.005	KHARK
27	13	14	-	27	12	15	+	136399.477(20)	0.001	KHARK
28	13	15	-	28	12	16	+	147052.543(20)	-0.008	KHARK
22	12	10	+	21	13	9	+	356650.139(50)	0.017	NIST
22	13	10	+	21	13	9	+	360753.732(50)	0.030	NIST
22	13	9	-	22	13	10	+	65718.144(20)	0.034	KHARK
23	13	10	-	23	13	11	+	85629.316(20)	0.022	KHARK
26	13	13	-	26	13	14	+	125470.208(20)	0.002	KHARK
27	13	14	-	27	13	15	+	136395.193(20)	-0.001	KHARK
28	13	15	-	28	13	16	+	147051.650(20)	-0.003	KHARK
17	14	3	+	16	13	4	+	362662.261(50)	0.015	NIST
14	14	1	-	14	13	2	+	90024.905(20)	0.006	KHARK
15	14	2	-	15	13	3	+	88368.022(20)	0.014	KHARK
16	14	3	-	16	13	4	+	86278.747(20)	-0.006	KHARK
17	14	4	-	17	13	5	+	83732.407(20)	-0.005	KHARK
18	14	5	-	18	13	6	+	80934.300(20)	-0.007	KHARK
19	14	6	-	19	13	7	+	78580.814(20)	-0.007	KHARK
20	14	7	-	20	13	8	+	77888.817(20)	-0.001	KHARK
21	14	8	-	21	13	9	+	80079.950(20)	0.009	KHARK
22	14	9	-	22	13	10	+	85633.097(20)	0.011	KHARK
23	14	10	-	23	13	11	+	94006.917(20)	0.018	KHARK
24	14	11	-	24	13	12	+	104078.591(20)	0.018	KHARK
25	14	12	-	25	13	13	+	114832.342(20)	0.011	KHARK
26	14	13	-	26	13	14	+	125693.602(20)	0.001	KHARK
27	14	14	-	27	13	15	+	136450.250(20)	0.000	KHARK
28	14	15	-	28	13	16	+	147064.405(20)	-0.009	KHARK
17	14	4	-	16	13	3	-	362517.471(50)	0.006	NIST
14	14	0	+	14	13	1	-	90023.835(20)	0.009	KHARK
15	14	1	+	15	13	2	-	88355.357(20)	0.001	KHARK
16	14	2	+	16	13	3	-	86180.197(20)	-0.005	KHARK
17	14	3	+	17	13	4	-	83170.722(20)	-0.010	KHARK
18	14	4	+	18	13	5	-	78507.213(20)	-0.016	KHARK
19	14	5	+	19	13	6	-	70762.119(20)	-0.025	KHARK
20	14	6	+	20	13	7	-	60054.509(20)	-0.024	KHARK
21	14	7	+	21	13	8	-	51590.616(50)	-0.010	KHARK
22	14	8	+	22	13	9	-	52105.026(20)	0.005	KHARK
23	14	9	+	23	13	10	-	63356.556(20)	0.016	KHARK
24	14	10	+	24	13	11	-	80637.086(20)	0.008	KHARK
25	14	11	+	25	13	12	-	97347.312(20)	0.007	KHARK
26	14	12	+	26	13	13	-	111316.556(20)	0.000	KHARK
27	14	13	+	27	13	14	-	123467.935(20)	0.002	KHARK
28	14	14	+	28	13	15	-	134755.252(20)	-0.001	KHARK
23	14	9	+	23	14	10	-	54978.986(20)	0.050	KHARK
24	14	10	+	24	14	11	-	77784.945(20)	0.011	KHARK
25	14	11	+	25	14	12	-	96507.667(20)	-0.030	KHARK
26	14	12	+	26	14	13	-	111093.168(20)	0.007	KHARK
27	14	13	+	27	14	14	-	123412.879(20)	0.002	KHARK
28	14	14	+	28	14	15	-	134742.489(20)	-0.003	KHARK
15	15	1	+	15	14	2	-	96634.799(20)	-0.024	KHARK
16	15	2	+	16	14	3	-	95023.236(20)	0.000	KHARK
17	15	3	+	17	14	4	-	93010.912(50)	0.056	NIST
18	15	4	+	18	14	5	-	90532.933(20)	-0.005	KHARK

19	15	5	+	19	14	6	-	87639.614(20) -0.006 KHARK	28	0	28	27	0	27	303180.768(50)	-0.155	NIST	9	-1	8	9	1	9	84396.128(20)	0.020	KHARK		
20	15	6	+	20	14	7	-	84723.555(20) 0.000 KHARK	1	1	1	0	0	0	16418.447(4)	-0.001	NIST	10	-1	9	10	1	10	94354.969(20)	0.002	KHARK		
21	15	7	+	21	14	8	-	82731.269(20) 0.007 KHARK	2	1	2	1	0	1	27205.592(4)	-0.003	NIST	11	-1	10	11	1	11	104311.380(20)	0.022	KHARK		
22	15	8	+	22	14	9	-	82979.768(20) 0.016 KHARK	3	1	3	2	0	2	37209.391(4)	0.000	NIST	12	-1	11	12	1	12	114265.636(20)	0.003	KHARK		
23	15	9	+	23	14	10	-	86473.442(20) 0.022 KHARK	6	1	6	5	0	5	68900.332(20)	-0.013	KHARK	13	-1	12	13	1	13	124217.975(20)	0.008	KHARK		
25	15	11	+	25	14	12	-	102516.750(20) 0.026 KHARK	7	1	7	6	0	6	79551.520(20)	-0.005	KHARK	14	-1	13	14	1	14	134168.439(20)	0.007	KHARK		
26	15	12	+	26	14	13	-	113039.017(20) 0.013 KHARK	8	1	8	7	0	7	90203.444(20)	-0.013	KHARK	15	-1	14	15	1	15	144117.052(20)	0.012	KHARK		
27	15	13	+	27	14	14	-	123970.440(20) 0.009 KHARK	9	1	9	8	0	8	100855.437(20)	0.006	KHARK	4	-2	2	3	1	3	103412.232(20)	-0.028	KHARK		
28	15	14	+	28	14	15	-	134888.766(20) -0.001 KHARK	10	1	10	9	0	9	111507.270(20)	-0.011	KHARK	2	2	1	2	1	2	17173.065(4)	0.001	NIST		
21	14	7	+	20	14	6	+	359623.150(50) 0.029 WLO88	11	1	11	10	0	10	122158.938(20)	-0.003	KHARK	3	2	2	3	1	3	25409.540(4)	0.002	NIST		
15	15	0	-	15	14	1	+	96634.440(20) -0.014 KHARK	12	1	12	11	0	11	132810.365(20)	-0.001	KHARK	4	2	3	4	1	4	34728.790(50)	-0.024	VAN81		
16	15	1	-	16	14	2	+	95018.538(20) -0.001 KHARK	13	1	13	12	0	12	143461.522(20)	-0.001	KHARK	7	2	6	7	1	7	64468.775(20)	0.009	KHARK		
18	15	3	-	18	14	4	+	90286.202(20) -0.009 KHARK	14	1	14	13	0	13	154112.470(50)	0.086	DEM82	8	2	7	8	1	8	74434.291(20)	0.000	KHARK		
19	15	4	-	19	14	5	+	86455.420(20) -0.009 KHARK	19	1	19	18	0	18	207361.390(50)	-0.027	DEM82	9	2	8	9	1	9	84396.128(20)	-0.012	KHARK		
20	15	5	-	20	14	6	+	80326.643(20) -0.011 KHARK	20	1	20	19	0	19	218010.000(50)	-0.018	DEM82	10	2	9	10	1	10	94354.969(20)	-0.002	KHARK		
21	15	6	-	21	14	7	+	70617.282(20) -0.011 KHARK	21	1	21	20	0	20	228658.140(50)	-0.028	DEM82	11	2	10	11	1	11	104311.380(20)	0.022	KHARK		
22	15	7	-	22	14	8	+	59398.554(20) -0.005 KHARK	26	1	26	25	0	25	281891.420(50)	-0.040	DEM82	12	2	11	12	1	12	114265.636(20)	0.003	KHARK		
23	15	8	-	23	14	9	+	53599.270(20) 0.013 KHARK	27	1	27	26	0	26	292536.450(50)	-0.037	DEM82	13	2	12	13	1	13	124217.975(20)	0.008	KHARK		
24	15	9	-	24	14	10	+	58640.615(20) 0.009 KHARK	28	1	28	27	0	27	303180.768(50)	-0.155	NIST	14	2	13	14	1	14	134168.439(20)	0.007	KHARK		
25	15	10	-	25	14	11	+	73517.996(20) -0.010 KHARK	2	-1	1	2	0	2	13025.272(4)	-0.001	NIST	15	2	14	15	1	15	144117.052(20)	0.012	KHARK		
26	15	11	-	26	14	12	+	91630.327(20) -0.018 KHARK	3	-1	2	3	0	3	23494.542(4)	0.000	NIST	2	-1	1	1	-1	0	33622.098(4)	0.003	NIST		
27	15	12	-	27	14	13	+	107595.542(20) -0.011 KHARK	4	-1	3	4	0	4	34241.090(50)	0.009	VAN81	6	-1	5	5	-1	4	78926.173(20)	-0.002	KHARK		
28	15	13	-	28	14	14	+	120930.151(20) -0.007 KHARK	7	-1	6	7	0	7	64466.791(20)	0.001	KHARK	7	-1	6	6	-1	5	89531.185(20)	-0.001	KHARK		
29	15	14	-	29	14	15	+	132808.168(20) -0.009 KHARK	8	-1	7	8	0	8	74434.035(20)	0.001	KHARK	8	-1	7	7	-1	6	100170.695(20)	-0.004	KHARK		
30	15	15	-	30	14	16	+	144003.721(20) -0.010 KHARK	9	-1	8	9	0	9	84396.128(20)	0.020	KHARK	9	-1	8	8	-1	7	110817.523(20)	0.019	KHARK		
23	14	9	+	22	15	8	+	352549.405(50) -0.034 NIST	10	-1	9	10	0	10	94354.969(20)	0.002	KHARK	10	-1	9	9	-1	8	121466.122(50)	-0.019	KHARK		
25	15	10	-	25	15	11	+	67508.951(20) -0.027 KHARK	11	-1	10	11	0	11	104311.380(20)	0.022	KHARK	11	-1	10	10	-1	9	132115.301(20)	-0.031	KHARK		
26	15	11	-	26	15	12	+	89684.472(20) -0.030 KHARK	12	-1	11	12	0	12	114265.636(20)	0.003	KHARK	12	-1	11	11	-1	10	142764.641(20)	-0.001	KHARK		
27	15	12	-	27	15	13	+	107037.988(20) -0.012 KHARK	13	-1	12	13	0	13	124217.975(20)	0.008	KHARK	13	-1	12	12	-1	11	153413.860(50)	0.003	DEM82		
28	15	13	-	28	15	14	+	120783.880(20) -0.004 KHARK	14	-1	13	14	0	14	134168.439(20)	0.007	KHARK	18	-1	17	17	-1	16	206655.240(50)	0.068	DEM82		
29	15	14	-	29	15	15	+	132772.345(20) -0.004 KHARK	15	-1	14	15	0	15	144117.052(20)	0.012	KHARK	19	-1	18	18	-1	17	217302.100(50)	-0.014	DEM82		
16	16	0	+	15	15	1	+	360015.570(50) -0.016 NIST	2	0	2	1	1	1	25156.159(4)	-0.002	NIST	25	-1	24	24	-1	23	281171.900(50)	0.006	DEM82		
16	16	1	-	16	15	2	+	103217.442(20) 0.014 KHARK	3	0	3	2	1	2	36701.712(50)	0.000	NIST	26	-1	25	25	-1	24	291814.660(50)	0.009	DEM82		
17	16	2	-	17	15	3	+	101644.857(50) 0.005 KHARK	6	0	6	5	1	5	68898.907(20)	0.027	KHARK	27	-1	26	26	-1	25	302456.577(50)	-0.140	NIST		
18	16	3	-	18	15	4	+	99704.861(20) 0.004 KHARK	7	0	7	6	1	6	79551.357(20)	0.004	KHARK	2	2	1	1	-1	0	38203.495(4)	0.004	NIST		
19	16	4	-	19	15	5	+	97321.366(20) -0.003 KHARK	8	0	8	7	1	7	90203.444(20)	0.006	KHARK	3	2	2	2	-1	1	49593.651(50)	-0.005	KHARK		
20	16	5	-	20	15	6	+	94462.952(20) -0.002 KHARK	9	0	9	8	1	8	100855.437(20)	0.008	KHARK	4	2	3	3	-1	2	58876.251(20)	-0.022	KHARK		
21	16	6	-	21	15	7	+	91299.045(20) 0.007 KHARK	10	0	10	9	1	9	111507.270(20)	-0.011	KHARK	5	2	4	4	-1	3	68564.561(20)	-0.005	KHARK		
22	16	7	-	22	15	8	+	88451.098(20) 0.017 KHARK	11	0	11	10	1	10	122158.938(20)	-0.003	KHARK	6	2	5	5	-1	4	78940.403(20)	-0.002	KHARK		
23	16	8	-	23	15	9	+	87083.231(20) 0.031 KHARK	12	0	12	11	1	11	132810.365(20)	-0.001	KHARK	7	2	6	6	-1	5	89533.178(20)	-0.001	KHARK		
24	16	9	-	24	15	10	+	88489.048(20) 0.039 KHARK	13	0	13	12	1	12	143461.522(20)	-0.001	KHARK	8	2	7	7	-1	6	100170.959(20)	0.000	KHARK		
26	16	11	-	26	15	12	+	101287.151(20) 0.034 KHARK	14	0	14	13	1	13	154112.470(50)	0.086	DEM82	9	2	8	8	-1	7	110817.523(20)	-0.013	KHARK		
21	15	6	-	20	15	5	-	349913.782(50) 0.023 WLO88	19	0	19	18	1	18	207361.390(50)	-0.027	DEM82	10	2	9	9	-1	8	121466.122(50)	-0.022	KHARK		
16	16	0	+	16	15	1	-	103217.314(20) 0.011 KHARK	20	0	20	19	1	19	218010.000(50)	-0.018	DEM82	11	2	10	10	-1	9	132115.301(20)	-0.031	KHARK		
17	16	1	+	17	15	2	-	101643.144(20) 0.007 KHARK	21	0	21	20	1	20	228658.140(50)	-0.028	DEM82	12	2	11	11	-1	10	142764.641(20)	-0.001	KHARK		
18	16	2	+	18	15	3	-	99689.286(20) 0.007 KHARK	26	0	26	25	1	25	281891.420(50)	-0.040	DEM82	13	2	12	12	-1	11	153413.860(50)	0.003	DEM82		
19	16	3	+	19	15	4	-	97216.518(20) -0.004 KHARK	27	0	27	26	1	26	292536.450(50)	-0.037	DEM82	18	2	17	17	-1	16	206655.240(50)	0.068	DEM82		
20	16	4	+	20	15	5	-	93912.882(20) 0.001 KHARK	28	0	28	27	1	27	303180.768(50)	-0.155	NIST	19	2	18	18	-1	17	217302.100(50)	-0.014	DEM82		
21	16	5	+	21	15	6	-	89012.597(20) 0.006 KHARK	3	-2	1	2	0	2	73138.311(50)	0.019	KHARK	25	2	24	24	-1	23	281171.900(50)	0.006	DEM82		
22	16	6	+	22	15	7	-	81078.392(20) 0.011 KHARK	3	3	1	2	0	2	81822.085(50)	-0.003	KHARK	26	2	25	25	-1	24	291814.660(50)	0.009	DEM82		
23	16	7	+	23	15	8	-	69652.841(20) 0.025 KHARK	4	3	2	3	0	3	108568.803(50)	0.084	KHARK	27	2	26	26	-1	25	302456.577(50)	-0.140	NIST		
24	16	8	+	24	15	9	-	59233.161(20) 0.037 KHARK	2	1	2	1	1	1	25589.765(4)	-0.001	NIST	2	-2	0	2	-1	1	9031.243(4)	0.000	NIST		
25	16	9	+	25	15	10	-	57292.653(50) 0.025 KHARK	3	1	3	2	1	2	36775.787(4)	0.001	NIST	3	-2	1	3	-1	2	12508.433(4)	-0.001	NIST		
26	16	10	+	26	15	11	-	67002.830(20) -0.019 KHARK	6	1	6	5	1	5	68899.077(20)	0.043	KHARK	4	-2	2	4	-1	3	21613.645(4)	-0.001	NIST		
1	0	1		0	0	0		14802.618(4) -0.001 NIST	7	1	7	6	1	6	79551.357(20)	-0.014	KHARK	5	-2	3	5	-1	4	32996.560(50)	-0.079	VAN81		
2	0	2		1	0	1		26771.988(4) -0.001 NIST	8	1	8	7	1	7	90203.444(20)	0.004	KHARK	8	-2	6	8	-1	7	64132.209(50)	-0.004	KHARK		
3	0	3		2	0	2		37135.318(4) 0.001 NIST	9	1	9	8	1	8	100855.437(20)	0.008	KHARK	9	-2	7	9	-1	8	74136.705(20)	-0.006	KHARK		
6	0	6		5	0	5		68900.169(20) -0.022 KHARK	10	1	10	9	1	9	111507.270(20)	-0.011	KHARK	11	-2	9	11	-1	10	94099.123(50)	0.018	KHARK		
7	0	7		6	0	6		79551.520(20) 0.012 KHARK	11	1	11	10	1	10	122158.938(20)	-0.003	KHARK	12	-2	10	12	-1	11	104069.583(20)	0.010	KHARK		
8	0	8		7	0	7		90203.444(20) -0.011 KHARK	12	1	12	11	1	11	132810.365(20)	-0.001	KHARK	13	-2	11	13	-1	12	114035.595(20)	0.000	KHARK		
9	0	9		8	0	8		100855.437(20) 0.007 KHARK	13	1	13	12	1	12	143461.522(20)	-0.001	KHARK	14	-2	12	14	-1	13	123998.076(20)	-0.003	KHARK		
10	0	10		9	0	9		111507.270(20) -0.011 KHARK	14	1	14	13	1	13	154112.470(50)	0.086	DEM82	15	-2	13	15	-1	14	133957.570(20)	0.001	KHARK		
11	0	11		10	0	10		122158.938(20) -0.003 KHARK	19	1	19	18	1	18	207361.390(50)	-0.027	DEM82	16	-2	14	16	-1	15	143914.405(20)	0.004	KHARK		
12	0	12		11	0	11		132810.365(20) -0.001 KHARK	20	1	20	19	1	19	218010.000(50)	-0.018	DEM82	17	-2	15	17	-1	16	153868.768(50)	-0.006	KHARK		
13	0	13		12	0	12		143461.522(20) -0.001 KHARK	21	1	21	20	1	20	228658.140(50)	-0.028	DEM82	23	-2	21	23	-1	22	213546.470(50)	0.074	DEM82		
14	0	14		13	0	13		154112.470(50) 0.086 DEM82	26	1	26	25	1	25	281891.420(50)	-0.040	DEM82	24	-2	22	24	-1	23	223484.380(100)	0.025	LILLE		
19	0	19		18	0	18		207361.390(50) -0.027 DEM82	27	1	27	26	1	26	292536.450(50)	-0.037	DEM82	4	-1	3	3	2	2	56389.075(20)	0.000	KHARK		
20	0	20		19	0	19		218010.000(50) -0.018 DEM82	28	1	28	27	1	27	303180.768(50)	-0.155	NIST	5	-1	4	4	2	3	67974.950(20)	-0.002	KHARK		
21	0	21		20	0	20		228658.140(50) -0.028 DEM82	2	-1	1	2	1	2	12591.669(4)	0.001	NIST	6	-1	5	5	2	4	78834.686(20)	-0.002	KHARK		
26	0	26		25	0	25		281891.420(50) -0.040 DEM82	3	-1	2	3	1	3	23420.471(4)	0.004	NIST	7	-1	6	6	2	5	89516.958(20)	0.003	KHARK		
27	0	27		26	0	26		292536.450(50) -0.037 DEM82	8	-1	7	8	1	8	74434.035(20)	0.003	KHARK	8	-1	7	7	2	6	100168.708(20)	0.002	KHARK		

TABLE 3—*Continued*

J'	K_a'	K_c'	P'	J"	K_a''	K_c''	P"	Observed (Unc)	O - C	Source
9	-1	8		8	2	7		110817.249(20)	0.004	KHARK
10	-1	9		9	2	8		121466.122(50)	0.013	KHARK
11	-1	10		10	2	9		132115.301(20)	-0.027	KHARK
12	-1	11		11	2	10		142764.641(20)	0.000	KHARK
13	-1	12		12	2	11		153413.860(50)	0.003	DEM82
18	-1	17		17	2	16		206655.240(50)	0.068	DEM82
19	-1	18		18	2	17		217302.100(50)	-0.014	DEM82
25	-1	24		24	2	23		281171.900(50)	0.006	DEM82
26	-1	25		25	2	24		291814.660(50)	0.009	DEM82
27	-1	26		26	2	25		302456.577(50)	-0.140	NIST
3	1	3		2	-2	0		15152.877(4)	0.002	NIST
4	1	4		3	-2	1		11639.025(4)	0.000	NIST
3	-1	2		2	-2	0		38573.344(4)	0.001	NIST
5	-3	2		4	-1	3		121199.670(50)	0.009	KHARK
8	3	6		8	-1	7		64145.955(20)	0.013	KHARK
11	3	9		11	-1	10		94099.123(50)	-0.019	KHARK
12	3	10		12	-1	11		104069.583(20)	0.006	KHARK
13	3	11		13	-1	12		114035.595(20)	-0.001	KHARK
14	3	12		14	-1	13		123998.076(20)	-0.003	KHARK
15	3	13		15	-1	14		133957.570(20)	0.001	KHARK
16	3	14		16	-1	15		143914.405(20)	0.004	KHARK
17	3	15		17	-1	16		153868.768(50)	-0.006	KHARK
23	3	21		23	-1	22		213546.470(50)	0.074	DEM82
24	3	22		24	-1	23		223484.380(100)	0.025	LILLE
5	2	4		4	2	3		68066.437(20)	-0.002	KHARK
6	2	5		5	2	4		78848.915(20)	-0.003	KHARK
7	2	6		6	2	5		89518.953(20)	0.004	KHARK
8	2	7		7	2	6		100168.969(20)	0.004	KHARK
9	2	8		8	2	7		110817.249(20)	-0.028	KHARK
10	2	9		9	2	8		121466.122(50)	0.010	KHARK
11	2	10		10	2	9		132115.301(20)	-0.028	KHARK
12	2	11		11	2	10		142764.641(20)	0.000	KHARK
13	2	12		12	2	11		153413.860(50)	0.003	DEM82
18	2	17		17	2	16		206655.240(50)	0.068	DEM82
19	2	18		18	2	17		217302.100(50)	-0.014	DEM82
25	2	24		24	2	23		281171.900(50)	0.006	DEM82
26	2	25		25	2	24		291814.660(50)	0.009	DEM82
27	2	26		26	2	25		302456.577(50)	-0.140	NIST
3	-2	1		3	2	2		10519.364(4)	0.001	NIST
4	-2	2		4	2	3		21115.522(4)	0.003	NIST
8	-2	6		8	2	7		64131.945(50)	-0.008	KHARK
9	-2	7		9	2	8		74136.705(20)	0.026	KHARK
11	-2	9		11	2	10		94099.123(20)	0.019	KHARK
12	-2	10		12	2	11		104069.583(20)	0.010	KHARK
13	-2	11		13	2	12		114035.595(20)	0.000	KHARK
14	-2	12		14	2	13		123998.076(20)	-0.003	KHARK
15	-2	13		15	2	14		133957.570(20)	0.001	KHARK
16	-2	14		16	2	15		143914.405(20)	0.004	KHARK
17	-2	15		17	2	16		153868.768(50)	-0.006	KHARK
23	-2	21		23	2	22		213546.470(50)	0.074	DEM82
24	-2	22		24	2	23		223484.380(100)	0.025	LILLE
3	-3	0		2	2	1		69606.988(50)	-0.008	KHARK
4	-3	1		3	2	2		91619.722(20)	-0.003	KHARK
3	3	1		3	2	2		19203.162(4)	0.004	NIST
4	3	2		4	2	3		26197.900(200)	-0.005	KRI71
5	3	3		5	2	4		34730.760(50)	-0.095	VAN81
8	3	6		8	2	7		64145.689(20)	0.007	KHARK
9	3	7		9	2	8		74138.737(20)	0.001	KHARK
11	3	9		11	2	10		94099.123(20)	-0.019	KHARK
12	3	10		12	2	11		104069.583(20)	0.006	KHARK
13	3	11		13	2	12		114035.595(20)	-0.001	KHARK
14	3	12		14	2	13		123998.076(20)	-0.003	KHARK
15	3	13		15	2	14		133957.570(20)	0.001	KHARK
16	3	14		16	2	15		143914.405(20)	0.004	KHARK
17	3	15		17	2	16		153868.768(50)	-0.006	KHARK
23	3	21		23	2	22		213546.470(50)	0.074	DEM82
24	3	22		24	2	23		223484.380(100)	0.025	LILLE
3	-2	1		2	-2	0		51081.771(50)	-0.005	KHARK
4	-2	2		3	-2	1		67483.365(50)	0.007	KHARK
5	-2	3		4	-2	2		79856.066(20)	-0.006	KHARK
6	-2	4		5	-2	3		89756.195(20)	-0.001	KHARK

J'	K_a'	K_c'	P'	J"	K_a''	K_c''	P"	Observed (Unc)	O - C	Source
7	-2	5		6	-2	4		99779.138(20)	0.009	KHARK
8	-2	6		7	-2	5		110228.308(20)	-0.001	KHARK
9	-2	7		8	-2	6		120821.996(20)	-0.007	KHARK
10	-2	8		9	-2	7		131452.024(20)	0.004	KHARK
11	-2	9		10	-2	8		142091.870(50)	0.024	KHARK
12	-2	10		11	-2	9		152735.077(50)	-0.033	KHARK
18	-2	16		17	-2	15		216607.220(50)	0.020	DEM82
19	-2	17		18	-2	16		227251.890(50)	0.039	DEM82
24	-2	22		23	-2	21		280466.450(50)	0.022	DEM82
25	-2	23		24	-2	22		291107.350(50)	0.041	DEM82
26	-2	24		25	-2	23		301747.298(50)	-0.137	NIST
5	3	3		4	-2	2		81681.773(20)	-0.001	KHARK
6	3	4		5	-2	3		90193.751(20)	-0.004	KHARK
7	3	5		6	-2	4		99862.289(20)	0.008	KHARK
8	3	6		7	-2	5		110242.032(20)	-0.006	KHARK
9	3	7		8	-2	6		120824.056(20)	-0.003	KHARK
10	3	8		9	-2	7		131452.306(20)	-0.001	KHARK
11	3	9		10	-2	8		142091.870(50)	-0.013	KHARK
12	3	10		11	-2	9		152735.150(50)	0.036	DEM82
18	3	16		17	-2	15		216607.220(50)	0.020	DEM82
19	3	17		18	-2	16		227251.890(50)	0.039	DEM82
24	3	22		23	-2	21		280466.450(50)	0.022	DEM82
25	3	23		24	-2	22		291107.350(50)	0.041	DEM82
26	3	24		25	-2	23		301747.298(50)	-0.137	NIST
3	-3	0		3	-2	1		14075.375(4)	0.002	NIST
4	-3	1		4	-2	2		13617.003(4)	-0.001	NIST
5	-3	2		5	-2	3		19729.944(4)	0.001	NIST
8	-3	5		8	-2	6		53361.610(50)	0.002	KHARK
9	-3	6		9	-2	7		63625.698(20)	0.000	KHARK
10	-3	7		10	-2	8		73716.642(20)	-0.003	KHARK
11	-3	8		11	-2	9		83750.771(20)	-0.016	KHARK
12	-3	9		12	-2	10		93760.426(20)	-0.002	KHARK
13	-3	10		13	-2	11		103756.089(20)	0.023	KHARK
14	-3	11		14	-2	12		113742.265(20)	-0.001	KHARK
15	-3	12		15	-2	13		123721.514(20)	-0.005	KHARK
16	-3	13		16	-2	14		133695.346(20)	-0.004	KHARK
17	-3	14		17	-2	15		143664.736(20)	-0.006	KHARK
18	-3	15		18	-2	16		153630.330(100)	-0.018	LILLE
24	-3	21		24	-2	22		213360.810(50)	-0.013	DEM82
5	-2	3		4	3	2		74773.684(20)	-0.002	KHARK
6	-2	4		5	3	3		87930.495(20)	0.001	KHARK
7	-2	5		6	3	4		99341.571(20)	0.000	KHARK
8	-2	6		7	3	5		110145.152(20)	-0.004	KHARK
9	-2	7		8	3	6		120808.269(20)	-0.005	KHARK
10	-2	8		9	3	7		131449.961(20)	-0.003	KHARK
11	-2	9		10	3	8		142091.569(50)	0.010	KHARK
12	-2	10		11	3	9		152735.077(50)	0.005	KHARK
18	-2	16		17	3	15		216607.220(50)	0.020	DEM82
19	-2	17		18	3	16		227251.890(50)	0.039	DEM82
24	-2	22		23	3	21		280466.450(50)	0.022	DEM82
25	-2	23		24	3	22		291107.350(50)	0.041	DEM82
26	-2	24		25	3	23		301747.298(50)	-0.137	NIST
5	-4	1		4	-2	2		116723.672(50)	0.027	KHARK
6	-4	2		5	-2	3		139576.794(50)	-0.010	KHARK
8	4	5		8	-2	6		53705.794(50)	0.002	KHARK
9	4	6		9	-2	7		63692.393(20)	-0.004	KHARK
10	4	7		10	-2	8		73728.090(20)	-0.002	KHARK
11	4	8		11	-2	9		83752.547(20)	-0.036	KHARK
12	4	9		12	-2	10		93760.684(20)	-0.007	KHARK
13	4	10		13	-2	11		103756.089(20)	-0.013	KHARK
14	4	11		14	-2	12		113742.265(20)	-0.006	KHARK
15	4	12		15	-2	13		123721.514(20)	-0.005	KHARK
16	4	13		16	-2	14		133695.346(20)	-0.004	KHARK
17	4	14		17	-2	15		143664.736(20)	-0.006	KHARK
4	3	2		3	3	1		63881.951(20)	0.002	KHARK
5	3	3		4	3	2		76599.392(20)	0.003	KHARK
6	3	4		5	3	3		88368.022(20)	-0.030	KHARK
7	3	5		6	3	4		99424.727(20)	0.004	KHARK
8	3	6		7	3	5		110158.882(50)	-0.003	KHARK
9	3	7		8	3	6		120810.327(20)	-0.004	KHARK
10	3	8		9	3	7		131450.243(20)	-0.007	KHARK

J'	K_a'	K_c'	P'	J"	K_a''	K_c''	P"	Observed (Unc)	O - C	Source
11	3	9		10	3	8		142091.569(50)	-0.028	KHARK
12	3	10		11	3	9		152735.077(50)	0.000	KHARK
18	3	16		17	3	15		216607.220(50)	0.020	DEM82
19	3	17		18	3	16		227251.890(50)	0.039	DEM82
24	3	22		23	3	21		280466.450(50)	0.022	DEM82
25	3	23		24	3	22		291107.350(50)	0.041	DEM82
26	3	24		25	3	23		301747.298(50)	-0.137	NIST
4	-3	1		4	3	2		8534.616(4)	-0.003	NIST
5	-3	2		5	3	3		17904.242(4)	0.001	NIST
6	-3	3		6	3	4		30348.170(200)	0.039	KRI71
8	-3	5		8	3	6		53347.887(50)	0.007	KHARK
9	-3	6		9	3	7		63623.634(20)	-0.008	KHARK
10	-3	7		10	3	8		73716.358(20)	-0.001	KHARK
11	-3	8		11	3	9		83750.771(20)	0.021	KHARK
12	-3	9		12	3	10		93760.426(20)	0.003	KHARK
13	-3	10		13	3	11		103756.089(20)	0.024	KHARK
14	-3	11		14	3	12		113742.265(20)	-0.001	KHARK
15	-3	12		15	3	13		123721.514(20)	-0.005	KHARK
16	-3	13		16	3	14		133695.346(20)	-0.004	KHARK
17	-3	14		17	3	15		143664.736(20)	-0.006	KHARK
18	-3	15		18	3	16		153630.330(100)	-0.018	LILLE
24	-3	21		24	3	22		213360.810(50)	-0.013	DEM82
5	-4	1		4	3	2		111641.266(50)	0.007	NIST
4	4	1		4	3	2		22453.449(4)	0.007	NIST
6	4	3		6	3	4		35024.240(50)	0.023	VAN81
8	4	5		8	3	6		53692.062(50)	-0.001	KHARK
9	4	6		9	3	7		63690.340(20)	0.000	KHARK
10	4	7		10	3	8		73727.804(20)	-0.002	KHARK
11	4	8		11	3	9		83752.547(20)	0.001	KHARK
12	4	9		12	3	10		93760.684(20)	-0.002	KHARK
13	4	10		13	3	11		103756.089(20)	-0.013	KHARK
14	4	11		14	3	12		113742.265(20)	-0.006	KHARK
15	4	12		15	3	13		123721.514(20)	-0.005	KHARK
16	4	13		16	3	14		133695.346(20)	-0.004	KHARK
17	4	14		17	3	15		143664.736(20)	-0.006	KHARK
18	4	15		18	3	16		153630.330(100)	-0.018	LILLE
24	4	21		24	3	22		213360.810(50)	-0.013	DEM82
4	-3	1		3	-3	0		67024.994(50)	0.004	KHARK
5	-3	2		4	-3	1		85969.010(20)	-0.001	KHARK
6	-3	3		5	-3	2		100811.955(20)	0.013	KHARK
7	-3	4		6	-3	3		111553.709(20)	-0.010	KHARK
8	-3	5		7	-3	4		121029.633(20)	-0.005	KHARK
9	-3	6		8	-3	5		131086.091(20)	-0.002	KHARK
10	-3	7		9	-3	6		141542.964(20)	-0.003	KHARK
17	-3	14		16	-3	13		215931.500(50)	-0.003	DEM82
18	-3	15		17	-3	14		226572.830(100)	0.024	LILLE
19	-3	16		18	-3	15		237214.260(100)	0.154	LILLE
23	-3	20		22	-3	19		279775.700(50)	-0.011	DEM82
24	-3	21		23	-3	20		290414.670(50)	0.007	DEM82
30	-3	27		29	-3	26		354231.529(50)	0.040	WLO88
4	4	1		3	-3	0		80943.801(50)	-0.011	KHARK
5	4	2		4	-3	1		95511.891(50)	0.060	NIST
6	4	3		5	-3	2		105488.031(20)	0.003	KHARK
7	4	4		6	-3	3		113032.847(20)	-0.003	KHARK
8	4	5		7	-3	4		121373.818(20)	-0.003	KHARK
9	4	6		8	-3	5		131152.787(20)	-0.004	KHARK
10	4	7		9	-3	6		141554.414(20)	0.000	KHARK
11	4	8		10	-3	7		152127.782(50)	-0.002	KHARK
17	4	14		16	-3	13		215931.500(50)	-0.003	DEM82
18	4	15		17	-3	14		226572.830(100)	0.024	LILLE
19	4	16		18	-3	15		237214.260(100)	0.154	LILLE
30	4	27		29	-3	26		354231.529(50)	0.040	WLO88
4	-4	0		4	-3	1		20797.733(4)	0.003	NIST
5	-4	1		5	-3	2		17137.629(4)	-0.001	NIST
6	-4	2		6	-3	3		19034.950(200)	0.032	KRI71
7	-4	3		7	-3	4		27976.500(50)	-0.068	VAN81
9	-4	5		9	-3	6		52113.564(50)	-0.001	KHARK
10	-4	6		10	-3	7		62850.047(20)	0.000	KHARK
11	-4	7		11	-3	8		73129.220(20)	-0.004	KHARK
12	-4	8		12	-3	9		83254.343(20)	-0.007	KHARK
13	-4	9		13	-3	10		93320.310(50)	0.003	NIST

14	-4	10	14	-3	11	103356.455(20)	-0.006	KHARK	23	-4	19	22	-4	18	289739.830(50)	0.009	DEM82	18	6	13	18	5	14	132983.341(20)	-0.014	KHARK
15	-4	11	15	-3	12	113374.066(20)	0.011	KHARK	24	-4	20	23	-4	19	300375.420(50)	0.033	NIST	19	6	14	19	5	15	142995.561(20)	-0.016	KHARK
16	-4	12	16	-3	13	123378.672(20)	-0.007	KHARK	29	-4	25	28	-4	24	353542.868(50)	0.020	NIST	20	6	15	20	5	16	152997.980(50)	-0.055	DEM82
17	-4	13	17	-3	14	133373.623(20)	-0.012	KHARK	30	-4	26	29	-4	25	364173.754(50)	0.028	NIST	26	6	21	26	5	22	212880.940(50)	-0.047	DEM82
18	-4	14	18	-3	15	143361.037(20)	-0.010	KHARK	6	5	2	5	-4	1	117815.159(50)	0.040	NIST	6	-5	1	5	-5	0	97803.499(20)	-0.001	KHARK
19	-4	15	19	-3	16	153342.310(50)	-0.029	DEM82	7	5	3	6	-4	2	129739.071(20)	0.000	KHARK	7	-5	2	6	-5	1	117925.297(20)	-0.010	KHARK
25	-4	21	25	-3	22	213140.270(50)	0.004	DEM82	8	5	4	7	-4	3	137231.304(20)	-0.002	KHARK	8	-5	3	7	-5	2	138423.001(20)	0.004	KHARK
6	-3	3	5	4	2	91269.116(20)	-0.005	KHARK	9	5	5	8	-4	4	144002.069(20)	-0.003	KHARK	9	-5	4	8	-5	3	154293.580(100)	0.069	LILLE
7	-3	4	6	4	3	106877.638(20)	0.005	KHARK	10	5	6	9	-4	5	152534.252(50)	-0.012	KHARK	17	-5	12	16	-5	11	235967.520(100)	-0.002	LILLE
8	-3	5	7	4	4	119550.520(20)	0.013	KHARK	18	5	14	17	-4	13	236560.320(100)	0.102	LILLE	22	-5	17	21	-5	16	289091.760(50)	0.032	DEM82
9	-3	6	8	4	5	130741.908(20)	-0.001	KHARK	24	5	20	23	-4	19	300375.420(50)	0.033	NIST	28	-5	23	27	-5	22	352871.923(50)	0.028	WLO88
10	-3	7	9	4	6	141476.266(20)	-0.002	KHARK	29	5	25	28	-4	24	353542.868(50)	0.020	NIST	29	-5	24	28	-5	23	363500.157(50)	0.014	NIST
11	-3	8	10	4	7	152114.530(50)	-0.011	DEM82	30	5	26	29	-4	25	364173.754(50)	0.028	NIST	7	6	2	6	-5	1	139487.732(20)	-0.034	KHARK
18	-3	15	17	4	14	226572.830(100)	0.024	LILLE	6	-5	1	6	-4	2	23178.859(4)	0.002	NIST	8	6	3	7	-5	2	153618.030(100)	0.085	LILLE
19	-3	16	18	4	15	237214.260(100)	0.154	LILLE	7	-5	2	7	-4	3	20608.791(4)	-0.004	NIST	17	6	12	16	-5	11	235967.520(100)	-0.026	LILLE
30	-3	27	29	4	26	354231.529(50)	0.040	WLO88	8	-5	3	8	-4	4	25663.721(4)	0.000	NIST	22	6	17	21	-5	16	289091.760(50)	0.032	DEM82
9	5	5	9	-3	6	53230.969(50)	-0.011	KHARK	9	-5	4	9	-4	5	37072.560(50)	-0.016	VAN81	28	6	23	27	-5	22	352871.923(50)	0.028	WLO88
10	5	6	10	-3	7	63104.867(20)	0.004	KHARK	10	-5	5	10	-4	6	49983.795(50)	0.004	KHARK	29	6	24	28	-5	23	363500.157(50)	0.014	NIST
11	5	7	11	-3	8	73179.233(20)	0.010	KHARK	11	-5	6	11	-4	7	61625.822(20)	-0.002	KHARK	6	-6	0	6	-5	1	35114.030(50)	-0.076	VAN81
12	5	8	12	-3	9	83263.184(20)	0.019	KHARK	12	-5	7	12	-4	8	72299.314(20)	0.002	KHARK	7	-6	1	7	-5	2	30771.400(200)	0.208	KRI71
14	5	10	14	-3	11	103356.679(20)	0.001	KHARK	13	-5	8	13	-4	9	82596.108(20)	-0.002	KHARK	8	-6	2	8	-5	3	25092.530(200)	0.013	KRI71
15	5	11	15	-3	12	113374.066(20)	-0.020	KHARK	14	-5	9	14	-4	10	92755.355(100)	-0.086	NIST	9	-6	3	9	-5	4	25171.536(4)	-0.006	NIST
16	5	12	16	-3	13	123378.672(20)	-0.011	KHARK	15	-5	10	15	-4	11	102853.769(20)	-0.004	KHARK	10	-6	4	10	-5	5	33567.710(50)	-0.021	VAN81
17	5	13	17	-3	14	133373.623(20)	-0.013	KHARK	16	-5	11	16	-4	12	112917.627(20)	-0.014	KHARK	12	-6	6	12	-5	7	59654.533(50)	-0.003	KHARK
18	5	14	18	-3	15	143361.037(20)	-0.010	KHARK	17	-5	12	17	-4	13	122958.703(20)	0.000	KHARK	13	-6	7	13	-5	8	71090.992(20)	0.004	KHARK
5	-4	1	5	3	3	35041.810(50)	-0.061	DEM82	18	-5	13	18	-4	14	132983.341(20)	-0.011	KHARK	14	-6	8	14	-5	9	81716.956(20)	-0.003	KHARK
5	-5	0	5	4	2	35679.420(50)	0.023	DEM82	19	-5	14	19	-4	15	142995.561(20)	-0.015	KHARK	15	-6	9	15	-5	10	92034.309(20)	-0.001	KHARK
6	-5	1	6	4	3	37537.750(50)	0.061	DEM82	20	-5	15	20	-4	16	152997.980(50)	-0.055	DEM82	16	-6	10	16	-5	11	102227.176(20)	-0.003	KHARK
5	4	2	4	4	1	81593.008(20)	0.000	KHARK	26	-5	21	26	-4	22	212880.940(50)	-0.047	DEM82	17	-6	11	17	-5	12	112357.431(20)	-0.015	KHARK
6	4	3	5	4	2	95945.210(20)	0.002	KHARK	7	-4	3	6	5	2	105389.485(50)	0.004	NIST	18	-6	12	18	-5	13	122449.251(100)	0.047	KHARK
7	4	4	6	4	3	108356.767(20)	0.003	KHARK	8	-4	4	7	5	3	124124.367(20)	-0.002	KHARK	19	-6	13	19	-5	14	132514.302(20)	-0.008	KHARK
9	4	6	8	4	5	130808.605(20)	-0.003	KHARK	9	-4	5	8	5	4	139021.421(20)	-0.001	KHARK	20	-6	14	20	-5	15	142559.731(20)	-0.021	KHARK
10	4	7	9	4	6	141487.712(20)	-0.003	KHARK	10	-4	6	9	5	5	151162.010(100)	-0.023	LILLE	21	-6	15	21	-5	16	152590.050(50)	-0.031	DEM82
11	4	8	10	4	7	152116.320(50)	-0.017	DEM82	18	-4	14	17	5	13	236560.320(100)	0.103	LILLE	8	-5	3	7	6	2	116860.503(20)	-0.035	KHARK
17	4	14	16	4	13	215931.500(50)	-0.003	DEM82	23	-4	19	22	5	18	289739.830(50)	0.009	DEM82	9	-5	4	8	6	3	139098.563(20)	0.000	KHARK
18	4	15	17	4	14	226572.830(100)	0.024	LILLE	24	-4	20	23	5	19	300375.420(50)	0.033	NIST	22	-5	17	21	6	16	289091.760(50)	0.032	DEM82
19	4	16	18	4	15	237214.260(100)	0.154	LILLE	29	-4	25	28	5	24	353542.868(50)	0.020	NIST	28	-5	23	27	6	22	352871.923(50)	0.028	WLO88
24	4	21	23	4	20	290414.670(50)	0.007	DEM82	30	-4	26	29	5	25	364173.754(50)	0.028	NIST	29	-5	24	28	6	23	363500.157(50)	0.014	NIST
30	4	27	29	4	26	354231.529(50)	0.040	WLO88	6	-4	2	5	-5	0	74624.613(50)	-0.030	KHARK	7	6	2	6	6	1	114032.170(20)	-0.009	KHARK
8	-4	4	8	4	5	39970.820(50)	0.002	VAN81	7	-4	3	6	-5	1	97316.512(20)	0.000	KHARK	8	6	3	7	6	2	132055.442(50)	-0.044	KHARK
9	-4	5	9	4	6	52046.858(50)	-0.009	KHARK	8	-4	4	7	-5	2	112759.193(50)	-0.083	NIST	9	6	4	8	6	3	147216.238(20)	-0.002	KHARK
10	-4	6	10	4	7	62838.607(50)	0.007	KHARK	6	5	2	5	5	1	98089.950(20)	0.002	KHARK	17	6	12	16	6	11	235967.520(100)	0.141	LILLE
11	-4	7	11	4	8	73127.443(20)	0.015	KHARK	7	5	3	6	5	2	114633.180(20)	-0.002	KHARK	22	6	17	21	6	16	289091.760(50)	0.032	DEM82
12	-4	8	12	4	9	83254.075(20)	-0.012	KHARK	9	5	5	8	5	4	140138.837(20)	0.000	KHARK	28	6	23	27	6	22	352871.923(50)	0.028	WLO88
13	-4	9	13	4	10	93320.310(50)	0.039	NIST	10	5	6	9	5	5	151416.840(100)	-0.009	LILLE	29	6	24	28	6	23	363500.157(50)	0.014	NIST
14	-4	10	14	4	11	103356.455(20)	-0.002	KHARK	18	5	14	17	5	13	236560.320(100)	0.103	LILLE	9	-6	3	9	6	4	17053.830(200)	-0.035	KRI71
15	-4	11	15	4	12	113374.066(20)	0.012	KHARK	23	5	19	22	5	18	289739.830(50)	0.009	DEM82	10	-6	4	10	6	5	30593.960(200)	0.062	KRI71
16	-4	12	16	4	13	123378.672(20)	-0.007	KHARK	24	5	20	23	5	19	300375.420(50)	0.033	NIST	13	-6	7	13	6	8	71055.056(20)	-0.003	KHARK
17	-4	13	17	4	14	133373.623(20)	-0.012	KHARK	29	5	25	28	5	24	353542.868(50)	0.020	NIST	14	-6	8	14	6	9	81710.505(20)	0.006	KHARK
18	-4	14	18	4	15	143361.037(20)	-0.010	KHARK	30	5	26	29	5	25	364173.754(50)	0.028	NIST	15	-6	9	15	6	10	92033.240(20)	0.005	KHARK
19	-4	15	19	4	16	153342.310(50)	-0.029	DEM82	8	-5	3	8	5	4	21800.488(4)	0.002	NIST	16	-6	10	16	6	11	102226.966(20)	-0.045	KHARK
25	-4	21	25	4	22	213140.270(50)	0.004	DEM82	9	-5	4	9	5	5	35955.120(50)	-0.041	VAN81	17	-6	11	17	6	12	112357.431(20)	0.010	KHARK
5	5	1	5	4	2	27319.960(200)	-0.021	KRI71	10	-5	5	10	5	6	49728.988(50)	0.013	KHARK	18	-6	12	18	6	13	122449.251(100)	0.050	KHARK
6	5	2	6	4	3	29464.520(200)	-0.200	KRI71	11	-5	6	11	5	7	61575.820(20)	-0.004	KHARK	19	-6	13	19	6	14	132514.302(20)	-0.007	KHARK
9	5	5	9	4	6	53164.283(50)	0.001	KHARK	12	-5	7	12	5	8	72290.492(20)	-0.004	KHARK	20	-6	14	20	6	15	142559.731(20)	-0.021	KHARK
10	5	6	10	4	7	63093.412(20)	-0.004	KHARK	13	-5	8	13	5	9	82594.676(50)	-0.004	KHARK	21	-6	15	21	6	16	152590.050(50)	-0.031	DEM82
11	5	7	11	4	8	73177.425(20)	-0.002	KHARK	14	-5	9	14	5	10	92755.355(100)	0.131	NIST	27	-6	21	27	6	22	212579.120(50)	-0.045	DEM82
12	5	8	12	4	9	83262.900(20)	-0.002	KHARK	15	-5	10	15	5	11	102853.769(20)	0.027	KHARK	11	7	5	11	6	6	52503.222(20)	0.000	KHARK
13	5	9	13	4	10	93321.664(50)	-0.037	NIST	16	-5	11	16	5	12	112917.627(20)	-0.010	KHARK	12	7	6	12	6	7	61653.945(20)	-0.003	KHARK
14	5	10	14	4	11	103356.679(20)	0.005	KHARK	17	-5	12	17	5	13	122958.703(20)	0.000	KHARK	13	7	7	13	6	8	71621.573(20)	-0.004	KHARK
15	5	11	15	4	12	113374.066(20)	-0.019	KHARK	18	-5	13	18	5	14	132983.341(20)	-0.010	KHARK	14	7	8	14	6	9	81836.517(20)	0.000	KHARK
16	5	12	16	4	13	123378.672(20)	-0.011	KHARK	19	-5	14	19	5	15	142995.561(20)	-0.015	KHARK	15	7	9	15	6	10	92058.316(20)	-0.004	KHARK
17	5	13	17	4	14	133373.623(20)	-0.013	KHARK	20	-5	15	20	5	16	152997.980(50)	-0.055	DEM82	16	7	10	16	6	11	102231.590(20)	0.002	KHARK
18	5	14	18	4	15	143361.037(20)	-0.010	KHARK	26	-5	21	26	5	22	212880.940(50)	-0.047	DEM82	17	7	11	17	6	12	112358.193(20)	-0.005	KHARK
19	5	15	19	4	16	153342.310(50)	-0.029	DEM82	10	6	5	10	5	6	52702.802(20)	-0.006	KHARK	18	7	12	18	6	13	122449.251(100)	-0.074	KHARK
5	-4	1	4	-4	0	82308.904(20)	-0.007	KHARK	11	6	6	11	5	7	62383.505(20)	-0.001	KHARK	19	7	13	19	6	14	132514.302(20)	-0.026	KHARK
6	-4	2	5	-4	1	102709.242(50)	0.012	NIST	12	6	7	12	5	8	72472.067(20)	-0.001	KHARK	20	7	14	20	6	15	142559.731(20)	-0.024	KHARK
7	-4	3	6	-4	2	120495.372(20)	0.003	KHARK	13	6	8	13	5	9	82630.609(20)	-0.001	KHARK	21	7	15	21	6	16	152590.050(50)	-0.031	DEM82
8	-4	4	7	-4	3	133368.070(20)	-0.001	KHARK	15	6	10	15	5	11	102854.822(20)	0.005	KHARK	7	-6	1	6	-6	0	113582.421(50)	0.028	NIST
9	-4	5	8	-4	4	142884.649(20)	-0.008	KHARK	16	6	11	16	5	12	112917.794(20)	-0.011	KHARK	8	-6	2	7	-6	1	132744.316(20)	-0.007	KHARK
18	-4	14	17	-4	13	236560.320(100)	0.103	LILLE	17	6	12	17	5	13	122958.703(20)	-0.024	KHARK	9	-6	3	8	-6	2	154372.610(100)	0.074	LILLE

TABLE 3—*Continued*

J'	Ka'	Kc'	P'	J"	Ka"	Kc"	P"	Observed (Unc)	O - C	Source
16	-6	10		15	-6	9		235551.970(100)	0.103	LILLE
27	-6	21		26	-6	20		352224.437(50)	0.012	WLO88
28	-6	22		27	-6	21		362848.369(50)	-0.018	NIST
16	7	10		15	-6	9		235556.530(100)	0.085	LILLE
27	7	21		26	-6	20		352224.437(50)	0.012	WLO88
28	7	22		27	-6	21		362848.369(50)	-0.018	NIST
8	-7	1		8	-6	2		38581.600(50)	-0.014	VAN81
9	-7	2		9	-6	3		32188.010(50)	-0.033	VAN81
10	-7	3		10	-6	4		27524.060(50)	-0.026	VAN81
11	-7	4		11	-6	5		31153.080(200)	0.120	KRI71
11	-7	4		11	-6	5		31152.910(50)	-0.050	VAN81
13	-7	6		13	-6	7		56577.607(20)	0.003	KHARK
14	-7	7		14	-6	8		69265.841(50)	-0.001	KHARK
15	-7	8		15	-6	9		80513.722(20)	-0.001	KHARK
16	-7	9		16	-6	10		91109.459(20)	0.000	KHARK
17	-7	10		17	-6	11		101449.496(20)	-0.001	KHARK
18	-7	11		18	-6	12		111674.682(20)	-0.015	KHARK
19	-7	12		19	-6	13		121835.810(20)	-0.018	KHARK
20	-7	13		20	-6	14		131954.981(100)	0.019	KHARK
21	-7	14		21	-6	15		142043.988(20)	-0.017	KHARK
22	-7	15		22	-6	16		152110.340(50)	-0.034	DEM82
9	6	4		8	-7	1		98737.041(50)	-0.016	KHARK
11	6	6		10	-7	3		113763.034(20)	-0.028	KHARK
16	-6	10		15	7	9		235526.810(100)	0.028	LILLE
27	-6	21		26	7	20		352224.437(50)	0.012	WLO88
28	-6	22		27	7	21		362848.369(50)	-0.018	NIST
8	7	2		7	7	1		129873.685(50)	-0.027	KHARK
9	7	3		8	7	2		148310.590(20)	-0.020	KHARK
16	7	10		15	7	9		235531.410(100)	0.050	LILLE
27	7	21		26	7	20		352224.437(50)	0.012	WLO88
28	7	22		27	7	21		362848.369(50)	-0.018	NIST
11	-7	4		11	7	5		24549.560(200)	0.223	KRI71
13	-7	6		13	7	7		56011.086(20)	0.000	KHARK
14	-7	7		14	7	8		69139.825(50)	0.000	KHARK
15	-7	8		15	7	9		80488.649(20)	0.011	KHARK
16	-7	9		16	7	10		91104.923(20)	0.041	KHARK
17	-7	10		17	7	11		101448.709(20)	-0.011	KHARK
18	-7	11		18	7	12		111674.520(20)	-0.053	KHARK
19	-7	12		19	7	13		121835.810(20)	0.001	KHARK
20	-7	13		20	7	14		131954.981(100)	0.022	KHARK
21	-7	14		21	7	15		142043.988(20)	-0.017	KHARK
22	-7	15		22	7	16		152110.340(50)	-0.034	DEM82
28	-7	21		28	7	22		212230.780(50)	-0.094	DEM82
12	8	5		12	7	6		52768.137(50)	0.010	KHARK
13	8	6		13	7	7		61075.550(20)	-0.003	KHARK
14	8	7		14	7	8		70685.969(20)	0.001	KHARK
15	8	8		15	7	9		80877.498(20)	-0.001	KHARK
16	8	9		16	7	10		91190.674(20)	-0.001	KHARK
17	8	10		17	7	11		101465.868(20)	-0.002	KHARK
18	8	11		18	7	12		111677.734(20)	-0.004	KHARK
19	8	12		19	7	13		121836.345(20)	-0.010	KHARK
20	8	13		20	7	14		131954.981(100)	-0.067	KHARK
21	8	14		21	7	15		142043.988(20)	-0.030	KHARK
8	-7	1		7	-7	0		129483.401(50)	-0.008	KHARK
9	-7	2		8	-7	1		147978.952(20)	-0.013	KHARK
26	-7	19		25	-7	18		351613.281(50)	0.020	WLO88
27	-7	20		26	-7	19		362228.918(50)	-0.006	NIST
26	8	19		25	-7	18		351613.281(50)	0.020	WLO88
27	8	20		26	-7	19		362228.918(50)	-0.006	NIST
11	-8	3		11	-7	4		33115.070(50)	0.021	VAN81
13	-8	5		13	-7	6		38620.840(50)	-0.035	VAN81
14	-8	6		14	-7	7		52289.872(20)	0.006	KHARK
15	-8	7		15	-7	8		66472.336(20)	0.004	KHARK
16	-8	8		16	-7	9		78802.893(20)	0.000	KHARK
17	-8	9		17	-7	10		89901.734(20)	-0.002	KHARK
18	-8	10		18	-7	11		100481.807(20)	0.000	KHARK
19	-8	11		19	-7	12		110845.589(20)	-0.009	KHARK
20	-8	12		20	-7	13		121101.497(100)	-0.027	KHARK
21	-8	13		21	-7	14		131292.020(20)	-0.017	KHARK
22	-8	14		22	-7	15		141437.561(50)	0.006	KHARK
23	-8	15		23	-7	16		151549.888(50)	-0.042	KHARK

J'	Ka'	Kc'	P'	J"	Ka"	Kc"	P"	Observed (Unc)	O - C	Source
26	-7	19		25	8	18		351613.281(50)	0.020	WLO88
27	-7	20		26	8	19		362228.918(50)	-0.006	NIST
11	7	5		10	-8	2		125701.208(50)	-0.004	KHARK
9	8	2		8	8	1		145730.729(20)	-0.028	KHARK
26	8	19		25	8	18		351613.281(50)	0.020	WLO88
27	8	20		26	8	19		362228.918(50)	-0.006	NIST
14	-8	6		14	8	7		50743.733(20)	0.011	KHARK
15	-8	7		15	8	8		66083.478(50)	0.007	KHARK
16	-8	8		16	8	9		78717.104(20)	0.004	KHARK
17	-8	9		17	8	10		89884.587(20)	0.000	KHARK
18	-8	10		18	8	11		100478.633(20)	-0.009	KHARK
19	-8	11		19	8	12		110845.056(20)	0.004	KHARK
20	-8	12		20	8	13		121101.497(100)	0.062	KHARK
21	-8	13		21	8	14		131292.020(20)	-0.004	KHARK
22	-8	14		22	8	15		141437.561(50)	0.008	KHARK
23	-8	15		23	8	16		151549.888(50)	-0.042	KHARK
29	-8	21		29	8	22		211831.930(50)	-0.129	DEM82
10	9	2		10	8	3		51670.209(50)	0.009	KHARK
13	9	5		13	8	6		53654.555(20)	-0.005	KHARK
14	9	6		14	8	7		60872.933(20)	-0.002	KHARK
15	9	7		15	8	8		69798.636(20)	-0.002	KHARK
16	9	8		16	8	9		79786.730(20)	0.002	KHARK
17	9	9		17	8	10		90147.182(20)	-0.003	KHARK
18	9	10		18	8	11		100536.193(20)	-0.001	KHARK
19	9	11		19	8	12		110856.581(20)	-0.010	KHARK
20	9	12		20	8	13		121103.581(20)	-0.002	KHARK
21	9	13		21	8	14		131292.381(20)	-0.017	KHARK
22	9	14		22	8	15		141437.561(50)	-0.054	KHARK
23	9	15		23	8	16		151549.888(50)	-0.051	KHARK
25	-8	17		24	-8	16		351065.849(50)	-0.079	WLO88
26	-8	18		25	-8	17		361663.729(50)	-0.016	NIST
19	9	11		18	-8	10		287809.200(50)	0.012	DEM82
25	9	17		24	-8	16		351065.849(50)	-0.079	WLO88
26	9	18		25	-8	17		361663.729(50)	-0.016	NIST
9	-9	0		9	-8	1		54996.891(20)	0.002	KHARK
10	-9	1		10	-8	2		52792.344(50)	0.002	KHARK
14	-9	5		14	-8	6		36419.460(50)	0.068	VAN81
16	-9	7		16	-8	8		62394.165(20)	0.009	KHARK
17	-9	8		17	-8	9		76284.615(20)	0.004	KHARK
18	-9	9		18	-8	10		88271.940(20)	-0.002	KHARK
19	-9	10		19	-8	11		99262.372(20)	-0.004	KHARK
20	-9	11		20	-8	12		109837.549(20)	-0.011	KHARK
21	-9	12		21	-8	13		120225.185(20)	-0.013	KHARK
22	-9	13		22	-8	14		130509.940(50)	-0.025	KHARK
23	-9	14		23	-8	15		140728.092(20)	-0.019	KHARK
19	-8	11		18	9	10		287740.090(50)	-0.008	DEM82
25	-8	17		24	9	16		351065.849(50)	-0.077	WLO88
26	-8	18		25	9	17		361663.729(50)	-0.016	NIST
19	9	11		18	9	10		287751.600(50)	-0.036	DEM82
25	9	17		24	9	16		351065.849(50)	-0.078	WLO88
26	9	18		25	9	17		361663.729(50)	-0.016	NIST
16	-9	7		16	9	8		61324.542(20)	0.014	KHARK
17	-9	8		17	9	9		76022.012(20)	0.000	KHARK
18	-9	9		18	9	10		88214.389(20)	-0.002	KHARK
19	-9	10		19	9	11		99250.835(20)	-0.003	KHARK
20	-9	11		20	9	12		109835.403(20)	-0.009	KHARK
21	-9	12		21	9	13		120224.878(20)	0.054	KHARK
22	-9	13		22	9	14		130509.940(50)	0.037	KHARK
23	-9	14		23	9	15		140728.092(20)	-0.009	KHARK
30	-9	21		30	9	22		211378.350(50)	-0.156	DEM82
16	-10	6		15	9	7		360483.932(50)	-0.005	NIST
13	-10	3		13	9	5		64735.859(20)	-0.001	KHARK
14	-10	4		14	9	6		67593.193(20)	-0.008	KHARK
15	-10	5		15	9	7		80939.216(20)	0.002	KHARK
10	10	1		10	9	2		61043.776(20)	0.023	KHARK
11	10	2		11	9	3		58755.724(20)	0.013	KHARK
12	10	3		12	9	4		55598.290(50)	-0.007	KHARK
13	10	4		13	9	5		53242.205(20)	-0.009	KHARK
14	10	5		14	9	6		55399.757(20)	-0.012	KHARK
15	10	6		15	9	7		61263.127(20)	-0.005	KHARK
16	10	7		16	9	8		69169.052(20)	0.002	KHARK

J'	Ka'	Kc'	P'	J"	Ka"	Kc"	P"	Observed (Unc)	O - C	Source
17	10	8		17	9	9		78658.952(20)	0.003	KHARK
18	10	9		18	9	10		88941.020(20)	0.005	KHARK
19	10	10		19	9	11		99425.920(20)	0.001	KHARK
20	10	11		20	9	12		109873.560(20)	-0.008	KHARK
21	10	12		21	9	13		120232.473(50)	-0.016	KHARK
22	10	13		22	9	14		130511.334(20)	-0.005	KHARK
23	10	14		23	9	15		140728.336(20)	-0.018	KHARK
25	-9	16		24	-9	15		361200.591(50)	-0.063	NIST
25	10	16		24	-9	15		361200.591(50)	-0.070	NIST
11	-10	1		10	-9	1		238899.020(100)	0.058	LILLE
10	-10	0		10	-9	1		61536.716(20)	0.010	KHARK
11	-10	1		11	-9	2		59512.535(50)	0.008	KHARK
12	-10	2		12	-9	3		56372.976(20)	0.000	KHARK
13	-10	3		13	-9	4		50294.796(50)	-0.002	KHARK
15	-10	5		15	-9	6		37246.280(50)	0.020	VAN81
17	-10	7		17	-9	8		57168.258(50)	0.017	KHARK
19	-10	9		19	-9	10		85981.582(20)	0.000	KHARK
20	-10	10		20	-9	11		97685.662(20)	0.000	KHARK
21	-10	11		21	-9	12		108601.464(20)	-0.001	KHARK
22	-10	12		22	-9	13		119179.038(20)	-0.008	KHARK
23	-10	13		23	-9	14		129589.846(20)	-0.015	KHARK
24	-10	14		24	-9	15		139901.370(20)	-0.026	KHARK
25	-9	16		24	10	15		361200.591(50)	-0.021	NIST
25	10	16		24	10	15		361200.591(50)	-0.028	NIST
17	-10	7		17	10	8		54531.327(20)	0.022	KHARK
18	-10	8		18	10	9		71852.721(20)	0.007	KHARK
19	-10	9		19	10	10		85806.501(20)	0.001	KHARK
20	-10	10		20	10	11		97647.511(20)	0.005	KHARK
21	-10	11		21	10	12		108593.799(20)	-0.001	KHARK
22	-10	12		22	10	13		119177.607(20)	-0.003	KHARK
23	-10	13		23	10	14		129589.595(20)	-0.013	KHARK
24	-10	14		24	10	15		139901.370(20)	0.017	KHARK
11	11	1		11	10	2		67941.046(20)	0.024	KHARK
12	11	2		12	10	3		65806.459(50)	0.012	KHARK
13	11	3		13	10	4		62832.703(20)	-0.011	KHARK
14	11	4		14	10	5		59335.515(20)	-0.010	KHARK
15	11	5		15	10	6		58517.722(20)	-0.018	KHARK
16	11	6		16	10	7		62420.905(20)	-0.011	KHARK
17	11	7		17	10	8		69048.296(20)	0.002	KHARK
18	11	8		18	10	9		77668.304(20)	0.006	KHARK
19	11	9		19	10	10		87632.910(20)	0.007	KHARK
21	11	11		21	10	12		108709.334(20)	0.005	KHARK
22	11	12		22	10	13		119202.655(20)	-0.008	KHARK
23	11	13		23	10	14		129594.631(20)	-0.016	KHARK
24	11	14		24	10	15		139902.290(20)	-0.013	KHARK
14	-10	4		13	-10	3		234078.760(100)	0.142	LILLE
23	-10	13		22	-10	12		350520.543(50)	-0.023	NIST
24	-10	14		23	-10	13		360956.315(50)	-0.100	NIST
23	11	13		22	-10	12		350525.618(50)	0.013	NIST
24	11	14		23	-10	13		360957.371(50)	0.007	NIST
11	-11	0		11	-10	1		68075.555(20)	0.008	KHARK
12	-11	1		12	-10	2		66162.954(20)	0.000	KHARK
13	-11	2		13	-10	3		63450.913(20)	-0.003	KHARK
14	-11	3		14	-10	4		58903.190(20)	-0.010	KHARK
18	-11	7		18	-10	8		51778.682(50)	0.018	KHARK
19	-11	8		19	-10	9		67484.283(20)	0.017	KHARK
20	-11	9		20	-10	10		82674.789(20)	0.008	KHARK
21	-11	10		21	-10	11		95568.402(20)	0.000	KHARK
22	-11	11		22	-10	12		107056.570(20)	0.007	KHARK
23	-11	12		23	-10	13		117923.137(20)	-0.004	KHARK
25	-11	14		25	-10	15		138940.345(20)	-0.032	KHARK
26	-11	15		26	-10	16		149276.471(50)	-0.025	KHARK
24	-10	14		23	11	13		360951.388(50)	0.012	WLO88
23	11	13		22	11	12		350500.537(50)	-0.015	NIST
24	11	14		23	11	13		360952.319(50)	-0.006	NIST
19	-11	8		19	11	9		65657.873(20)	0.009	KHARK
20	-11	9		20	11	10		82188.061(20)	0.007	KHARK
21	-11	10		21	11	11		95452.874(20)	0.001	KHARK
22	-11	11		22	11	12		107031.519(20)	0.009	KHARK
23	-11	12		23	11	13		117918.121(20)	0.019	KHARK
26	-11	15		26	11	16		149276.471(50)	0.004	KHARK

17	-12	5	16	11	6	359684.718(50)	-0.005	NIST
12	12	1	12	11	2	74838.408(20)	0.034	KHARK
14	12	3	14	11	4	70084.627(20)	-0.005	KHARK
15	12	4	15	11	5	66458.899(20)	-0.019	KHARK
16	12	5	16	11	6	63417.865(20)	-0.035	KHARK
17	12	6	17	11	7	64607.137(20)	-0.017	KHARK
18	12	7	18	11	8	69666.643(20)	-0.001	KHARK
19	12	8	19	11	9	77060.419(20)	0.008	KHARK
20	12	9	20	11	10	86355.125(20)	0.013	KHARK
21	12	10	21	11	11	96694.766(20)	0.010	KHARK
22	12	11	22	11	12	107353.917(20)	0.013	KHARK
23	12	12	23	11	13	117993.673(20)	-0.005	KHARK
25	12	14	25	11	15	138943.492(20)	0.000	KHARK
26	12	15	26	11	16	149277.071(20)	-0.017	KHARK
23	-11	12	22	-11	11	361387.112(50)	-0.031	NIST
22	12	11	21	-11	10	351994.821(50)	-0.026	WLO88
23	12	12	22	-11	11	361462.689(50)	-0.030	NIST
12	-12	0	12	-11	1	74621.795(20)	0.010	KHARK
14	-12	2	14	-11	3	70312.735(50)	-0.009	KHARK
15	-12	3	15	-11	4	66683.703(20)	-0.007	KHARK
16	-12	4	16	-11	5	60017.522(20)	-0.004	KHARK
17	-12	5	17	-11	6	49713.976(50)	-0.006	KHARK
20	-12	8	20	-11	9	61452.228(20)	0.021	KHARK
21	-12	9	21	-11	10	77986.307(20)	0.012	KHARK
22	-12	10	22	-11	11	92613.015(20)	-0.026	KHARK
23	-12	11	23	-11	12	105063.917(20)	-0.028	KHARK
24	-12	12	24	-11	13	116394.749(20)	0.002	KHARK
25	-12	13	25	-11	14	127230.069(20)	-0.005	KHARK
26	-12	14	26	-11	15	137823.853(20)	-0.008	KHARK
27	-12	15	27	-11	16	148276.950(100)	-0.029	KHARK
22	-11	11	21	12	10	350430.551(50)	-0.019	NIST
23	-11	12	22	12	11	361064.732(50)	-0.017	NIST
15	-12	3	15	11	5	78226.885(20)	-0.025	KHARK
16	-12	4	16	11	6	74846.815(20)	0.005	KHARK
17	-12	5	17	11	7	76837.803(20)	-0.004	KHARK
18	-12	6	18	11	8	89463.192(50)	0.003	KHARK
22	12	11	21	12	10	350752.907(50)	-0.057	WLO88
23	12	12	22	12	11	361140.285(50)	-0.040	NIST
20	-12	8	20	12	9	57285.172(50)	0.023	KHARK
21	-12	9	21	12	10	76744.415(20)	0.003	KHARK
22	-12	10	22	12	11	92290.659(20)	0.012	KHARK
23	-12	11	23	12	12	104988.344(20)	-0.025	KHARK
24	-12	12	24	12	13	116378.431(20)	0.000	KHARK
25	-12	13	25	12	14	127226.787(20)	-0.004	KHARK
26	-12	14	26	12	15	137823.225(20)	-0.016	KHARK
27	-12	15	27	12	16	148276.950(100)	0.082	KHARK
13	13	1	13	12	2	81736.443(20)	0.046	KHARK
14	13	2	14	12	3	79808.783(20)	0.018	KHARK
15	13	3	15	12	4	77270.314(20)	-0.003	KHARK
16	13	4	16	12	5	73882.976(50)	-0.021	KHARK
17	13	5	17	12	6	69907.986(20)	-0.036	KHARK
18	13	6	18	12	7	68273.197(50)	-0.031	KHARK
19	13	7	19	12	8	71209.142(20)	-0.007	KHARK
20	13	8	20	12	9	77108.711(50)	0.013	KHARK
21	13	9	21	12	10	85322.007(20)	0.023	KHARK
22	13	10	22	12	11	95199.745(20)	0.019	KHARK
23	13	11	23	12	12	105820.831(20)	0.020	KHARK
25	13	13	25	12	14	127275.839(20)	-0.026	KHARK
26	13	14	26	12	15	137833.769(20)	-0.021	KHARK
27	13	15	27	12	16	148278.991(20)	0.000	KHARK
21	-12	9	20	-12	8	359503.155(50)	-0.001	NIST
17	-13	4	16	-12	4	353760.936(50)	-0.011	NIST
18	13	6	17	-12	5	357280.959(50)	-0.025	NIST
13	-13	0	13	-12	1	81181.490(20)	0.012	KHARK
14	-13	1	14	-12	2	79404.053(20)	-0.003	KHARK
15	-13	2	15	-12	3	77084.649(20)	-0.013	KHARK
16	-13	3	16	-12	4	73936.120(20)	-0.019	KHARK
17	-13	4	17	-12	5	68923.023(20)	-0.010	KHARK
19	-13	6	19	-12	7	49296.227(20)	-0.006	KHARK
21	-13	8	21	-12	9	55823.849(20)	0.021	KHARK
23	-13	10	23	-12	11	88424.568(20)	0.003	KHARK

24	-13	11	24	-12	12	102389.083(20)	0.010	KHARK
25	-13	12	25	-12	13	114488.611(20)	0.002	KHARK
26	-13	13	26	-12	14	125707.573(20)	0.003	KHARK
27	-13	14	27	-12	15	136523.802(20)	0.001	KHARK
28	-13	15	28	-12	16	147127.875(50)	0.002	KHARK
22	-12	10	21	13	9	357721.566(50)	-0.061	NIST
17	-13	4	17	12	6	81153.688(20)	0.002	KHARK
18	-13	5	18	12	7	79457.227(20)	0.007	KHARK
19	-13	6	19	12	8	85751.363(50)	0.003	KHARK
22	13	10	21	13	9	360630.680(50)	-0.026	NIST
22	-13	9	22	13	10	68999.967(20)	-0.005	KHARK
23	-13	10	23	13	11	87592.113(20)	-0.009	KHARK
24	-13	11	24	13	12	102177.485(20)	-0.011	KHARK
25	-13	12	25	13	13	114439.533(20)	-0.002	KHARK
26	-13	13	26	13	14	125697.022(20)	0.002	KHARK
14	14	1	14	13	2	88633.961(20)	0.056	KHARK
15	14	2	15	13	3	86778.419(20)	0.022	KHARK
16	14	3	16	13	4	84394.030(20)	0.000	KHARK
17	14	4	17	13	5	81280.159(20)	-0.023	KHARK
18	14	5	18	13	6	77271.822(20)	-0.035	KHARK
19	14	6	19	13	7	73670.628(20)	-0.040	KHARK
20	14	7	20	13	8	73923.036(20)	-0.017	KHARK
21	14	8	21	13	9	78051.697(20)	0.013	KHARK
22	14	9	22	13	10	84811.083(20)	0.035	KHARK
23	14	10	23	13	11	93820.595(20)	0.040	KHARK
24	14	11	24	13	12	104168.338(20)	0.036	KHARK
25	14	12	25	13	13	114991.199(20)	0.018	KHARK
26	14	13	26	13	14	125834.795(20)	0.009	KHARK
27	14	14	27	13	15	136553.340(20)	0.004	KHARK
28	14	15	28	13	16	147134.235(50)	-0.013	KHARK
14	-14	0	14	-13	1	87759.311(20)	0.021	KHARK
15	-14	1	15	-13	2	86025.739(20)	-0.007	KHARK
16	-14	2	16	-13	3	83818.220(50)	-0.026	KHARK
17	-14	3	17	-13	4	80948.010(20)	-0.024	KHARK
18	-14	4	18	-13	5	76901.613(20)	-0.018	KHARK
19	-14	5	19	-13	6	69767.310(20)	0.001	KHARK
21	-14	7	21	-13	8	50064.070(50)	0.011	KHARK
22	-14	8	22	-13	9	52376.869(20)	0.019	KHARK
23	-14	9	23	-13	10	65264.019(20)	0.023	KHARK
24	-14	10	24	-13	11	82712.242(20)	0.000	KHARK
25	-14	11	25	-13	12	98677.034(20)	-0.002	KHARK
26	-14	12	26	-13	13	112025.187(20)	-0.001	KHARK
27	-14	13	27	-13	14	123859.651(20)	0.002	KHARK
28	-14	14	28	-13	15	135000.036(20)	0.006	KHARK
29	-14	15	29	-13	16	145805.048(20)	0.008	KHARK
21	14	8	20	14	7	352385.871(50)	0.061	NIST
24	-14	10	24	14	11	80721.404(20)	-0.031	KHARK
26	-14	12	26	14	13	111887.417(20)	-0.005	KHARK
28	-14	14	28	14	15	134993.264(20)	0.012	KHARK
29	-14	15	29	14	16	145803.685(50)	0.008	KHARK
15	15	1	15	14	2	95528.755(20)	0.062	KHARK
16	15	2	16	14	3	93732.676(20)	0.037	KHARK
17	15	3	17	14	4	91470.313(20)	0.008	KHARK
18	15	4	18	14	5	88584.609(20)	-0.020	KHARK
19	15	5	19	14	6	84851.138(20)	-0.036	KHARK
20	15	6	20	14	7	80494.484(20)	-0.043	KHARK
21	15	7	21	14	8	78152.818(20)	-0.032	KHARK
22	15	8	22	14	9	80070.807(20)	0.015	KHARK
23	15	9	23	14	10	85111.391(20)	0.046	KHARK
25	15	11	25	14	12	102523.328(20)	0.055	KHARK
26	15	12	26	14	13	113228.898(20)	0.041	KHARK
27	15	13	27	14	14	124190.146(20)	0.024	KHARK
28	15	14	28	14	15	135082.360(20)	0.016	KHARK
29	15	15	29	14	16	145823.986(20)	0.007	KHARK
21	-14	7	20	-14	6	360030.717(50)	0.002	NIST
15	-15	0	15	-14	1	94358.844(20)	0.026	KHARK
16	-15	1	16	-14	2	92659.386(20)	-0.027	KHARK
17	-15	2	17	-14	3	90537.499(20)	-0.024	KHARK
18	-15	3	18	-14	4	87854.056(20)	-0.038	KHARK
19	-15	4	19	-14	5	84323.248(20)	-0.031	KHARK
20	-15	5	20	-14	6	78918.330(20)	-0.005	KHARK

21	-15	6	21	-14	7	69082.140(20)	0.023	KHARK
22	-15	7	22	-14	8	57192.761(50)	0.032	KHARK
23	-15	8	23	-14	9	52561.318(20)	0.029	KHARK
24	-15	9	24	-14	10	59701.490(20)	0.025	KHARK
25	-15	10	25	-14	11	75747.892(20)	-0.001	KHARK
26	-15	11	26	-14	12	93525.254(50)	-0.026	KHARK
27	-15	12	27	-14	13	108713.616(20)	-0.012	KHARK
28	-15	13	28	-14	14	121550.402(20)	0.000	KHARK
29	-15	14	29	-14	15	133190.157(20)	0.010	KHARK
30	-15	15	30	-14	16	144275.337(20)	0.012	KHARK
23	-14	9	22	15	8	359735.620(50)	-0.070	NIST
21	15	7	20	15	6	350044.192(50)	0.059	NIST
25	-15	10	25	15	11	71349.957(20)	-0.053	KHARK
26	-15	11	26	15	12	92183.785(20)	-0.060	KHARK
27	-15	12	27	15	13	108351.468(20)	-0.029	KHARK
28	-15	13	28	15	14	121461.312(20)	0.001	KHARK
29	-15	14	29	15	15	133169.845(20)	0.000	KHARK
30	-15	15	30	15	16	144270.972(20)	-0.024	KHARK
16	16	1	16	15	2	102418.070(20)	0.085	KHARK
17	16	2	17	15	3	100672.259(20)	0.044	KHARK
18	16	3	18	15	4	98509.270(20)	0.020	KHARK
20	16	5	20	15	6	92368.362(20)	-0.029	KHARK
21	16	6	21	15	7	88046.021(20)	-0.042	KHARK
23	16	8	23	15	9	83364.837(20)	0.011	KHARK
25	16	10	25	15	11	92469.015(20)	0.084	KHARK
27	16	12	27	15	13	111389.823(20)	0.055	KHARK
28	16	13	28	15	14	122354.102(20)	0.043	KHARK
29	16	14	29	15	15	133405.695(20)	0.030	KHARK
30	16	15	30	15	16	144328.280(20)	0.022	KHARK
21	-15	6	20	-15	5	350194.487(50)	-0.009	WLO88
16	-16	0	16	-15	1	100982.790(20)	0.058	KHARK
17	-16	0	17	-15	2	99310.261(20)	0.002	KHARK
18	-16	0	18	-15	3	97255.953(20)	-0.031	KHARK
19	-16	0	19	-15	4	94710.797(20)	-0.043	KHARK
20	-16	0	20	-15	5	91487.314(20)	-0.042	KHARK
21	-16	0	21	-15	6	87077.261(20)	-0.017	KHARK
22	-16	0	22	-15	7	79564.306(50)	0.026	KHARK
23	-16	0	23	-15	8	67346.394(20)	0.064	KHARK
24	-16	0	24	-15	9	57041.477(20)	0.069	KHARK
25	-16	0	25	-15	10	57040.755(20)	0.046	KHARK
26	-16	0	26	-15	11	68740.560(20)	0.008	KHARK
27	-16	0	27	-15	12	86792.965(20)	-0.047	KHARK
28	-16	0	28	-15	13	104152.083(20)	-0.039	KHARK
29	-16	0	29	-15	14	118552.711(20)	-0.021	KHARK
30	-16	0	30	-15	15	130991.201(20)	0.007	KHARK
14	10	5	14	-9	5	29109.640(50)	0.051	DEM82
12	9	4	12	-8	4	30071.910(50)	0.012	DEM82
10	8	3	10	-7	3	29806.500(50)	-0.020	DEM82
5	-4	1	5	-2	3	36867.540(50)	-0.033	DEM82
15	-11	4	15	10	6	70060.942(20)	0.002	KHARK

gation of torsion–rotation transitions of CH_3COOH for astrophysical use, since it has considerably improved the rms deviations in comparison with previous studies.

The ground torsional state is in very good shape for levels with J up to 30, since a large body of microwave transitions involving these levels can be fit to experimental precision. Our understanding of levels with $v_t = 1$ must be improved by adding more of the existing pure rotational measurements for this state to the fit, since calculated $v_t = 1$ transitions at present can sometimes miss their (apparently) corresponding measured lines by several megahertz. (Adding large numbers of such "calculated assignments" to the fit without intermediate fits and other checks is dangerous, so such additions must proceed slowly and carefully.) There is some hope of ultimately including $v_t = 2$ levels in the fit, since the $v_t = 2$, $K = 0$, A state lies just below, and the $K = 0$, E state lies just above the top of the barrier in Fig. 1.

It should be noted that a cold molecular beam spectrum of the $v_t = 1 \leftarrow 0$ fundamental torsional band, which is predicted to lie near 79.1 and 72.8 cm^{-1} for the A and E species, respectively, will eventually be necessary to stabilize and properly constrain the pure torsional parameters F, V_3, V_6, etc. Such parameters are determined here only very indirectly from rotational intervals *within* each torsional state. Their fitted values are thus very susceptible to large systematic errors arising (i) from slight contamination of rotational–interval calculations by effects from vibrational averaging, (ii) from implicit reduction of the Hamiltonian by contact transformation, and (iii) from other phenomena not considered in the present model. (Surprisingly, however, the value of V_3 determined in this way has been remarkably stable, varying only between 168.0 and 170.2 cm^{-1} during the last 30 years (*5, 6, 8–10*).) Attempts to obtain a room-temperature spectrum of the torsional fundamental using a Fourier transform infrared spectrometer have been carried out in several laboratories, but only very weak features can be seen in the predicted regions (*36–38*). (It is possible that much of the acetic acid is present in dimeric form at the pressures needed for infrared studies.)

Were it not for the experimental difficulties associated with cooling and resolving the far-infrared torsion–rotation spectrum, acetic acid would be an ideal case for studying pure torsion–rotation interactions above the barrier, since the top of the barrier lies some 400 cm^{-1} below the lowest small-amplitude fundamental vibrations ν_{12} and ν_{17} (*31*). For this reason, we plan to continue work on its spectrum. An intensity calculation has been carried out, based on the assumption that the components of the permanent electric dipole moment, are driving the torsion–rotation transitions. This calculation will be used (i) to determine which additional weak lines should be searched for, e.g., which A lines with $|\Delta K_a| \geq 2$, $|\Delta K_c| \geq 3$ have reasonable intensity in this rather asymmetric top ($\kappa = +0.38$) and (ii) to determine if and why branches of the form $(J+1)_{Ka+1,J-Ka}$–$J_{Ka,J-Ka+1}$, for which we have so far found rather few lines, are predicted to be unexpectedly weak. In addition, we plan to greatly extend our $v_t = 1$ assignments and to begin including some $v_t = 2$ lines in the fits.

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