Harold M. Frost, III, Ph.D. – Mathematical Physicist, Principal Investigator, Inventor and Business Innovator

Physics degrees from The University of Vermont (UVM): **B.A. (1964). M.S. (1969) + Ph.D. (1974);** research theses advised by Prof. W.L. Nyborg (1917-2011) [WL**N**, p.10].

Exploratory Research in Generalized Radiation Effects Science & Technology: Discovered ion, nuclear, electromagnetic & mechanical radiation effects in solids, inspiring others' research. *Latest ex:* Proposed new isothermal, cavitation-free, non-hydrodynamic physical model, *solid-state mechanical shear-stress* [**SSMSS**, p.9] as endogenous *elastodynamic* [p.7] MUBEM akin to exogenous *acoustic* MUBEM, *fluid-state mech*. *shear stress* (**FSMSS**). **SSMSS** based on HMF's research on EIP [p.8] for combined DC & AC (20-90 kHz) line forces acting on viscoelastic (VE) solid with shear elastic modulus μ, causing max. DC & AC shear stresses on certain planes ['68-'69, '70-'74, p.1; '05-'07, p.2; 2nd #1, p.5; #2,6,10,14, p.6]. **FSMSS** MUBEM developed by JA**R** [p.10; *Science* **169:**869-871(1970); *J. Acoust. Soc. Am. (JASA)* **52:**1718-1724(1972)], via acoustic-micro-streaming-based DC & AC (20kHz) shear stress acting on plasma membrane of VE erythrocyte near fixed gas bubble stably pulsating in viscous liquid. Unable to inspire others to res./test **SSMSS** MUBEM due to mental-disability stigma blocking access to proj. co-workers, paper coauthors & ultrasound-safety watchdog like AIUM Bioeffects Committee.

Mental-Disability D&I Planning as Business Imperative to: Debunk (as by employer/employee case studies) the myth of persons stigmatized by, yet recovered from mental illness, as incapable of sound rational or math. reasoning or achieving at best-and-brightest STEM-worker level. Then help/return/retrain/retain older STEM-leader employees also serving as volunteers in prof. non-profits (e.g., AAAS, AIP, IEEE) & honor societies, who ***acquire*** major mental disability midcareer at work, ***self-disclose*** it to employer to secure insurer-approved leaves of absence (LOA's) & medical treatment, ***recover*** with transformed KSA's, ***return*** to *work* to enhance employer productivity/profitability as in new inventions/innovations (even if personal-assistance is needed), and ***continue*** with prof. memberships & service. Promote long-term career continuity of such late bloomers by abating LOA's adverse admin. side effects of lost: Security clearance, PI status, funding, independence, res. contacts, good job fit, respect of co-workers & finally, job itself.

EDUCATION and OUTCOMES as EXPERIMENTAL or MATHEMATICAL PHYSICIST – with G_{ij} EXAMPLES*

1954—1960 Pre high school (HS): Rocket-fuel chem. via home lab. HS sci.-fair proj.: Estimated sucrose mol. wt. by meas. conc. effect in H_2O on refraction via equip. loaned by WT**D**, cont'd '60-'61 in lab of RG**I** [p.10]. HS grad. 06/60 (Hon. Mention) [PK**S**, p.10].

1960—1964 **Univ. of Vermont (UVM), Burlington, VT:** Physics B.A. (math minor) and 2nd Lt. USAR commissioning via ARMY ROTC.

1960—1964 **VT, NH**. STEM summer jobs in college yrs: Digital computer I/O for N. Costes at CRREL; CMC exp'ts for Prof. A. Wishnia at DMS; ultrasonic cavitation res. for WLN; *ex vivo* chem. analysis for W.M. Stahl, M.D., UVM Med. School. ROTC training, 3yr.

1966—1966 **Microbiol. Lab (O.H. Calderon, head), AMTED, WSMR, NM: G_{31}.** On active duty dev. equiv. electr. circuits, wrote literature review for corrosive mycelial growth in Army electronics stored/used in tropics; aided by NMSU Biology Prof. E.E. Staffeldt.

1966—1967 **New Mexico State Univ., Las Cruces, NM:** During **AMTED** duty hrs, took grad. classes at NMSU in theo. physics methods; made up time by working at WSMR after hrs. **USAFI:** Passed Russian courses. **12/67:** Honorable discharge, Ft. Bliss, TX.

1968—1969 **UVM: G_{21}.** Physics M.S. degree with thesis [2nd item 1, p.5] for exp'ts on EIP [p.8]: Meas. depth vs. time of Mason-horn tip osc. as 20kHz CW dipole *point* or *piston* source forced by creep force $\mathbf{F_s}$ to penetrate agar-gel or wax block [$\langle|\mathbf{F_d}|\rangle > \mathbf{0}$], elucidating viscous flow, strain & other effects seen in past res. exposing single plant & other cells to 85kHz ultrasound [$\mathbf{F_s} \cong \mathbf{0}$].

1969—1969 **Brandeis Univ., Waltham, MA: G_{3j}.** In ½ yr of exploring quantum field theory for Ph.D. thesis under UVM Physics Prof. Leonard Scarfone, attended (with NSF funding) the '69 Summer Institute in Theo. Physics, *Atomic Physics & Astrophysics*.

1970—1974 **UVM: G_{2j}.** But chose WLN to advise Ph.D. thesis on EIP physics [#2, p.6]. Invented *self-excited* resonant-ultrasound imaging & spectroscopy system with design guided by photoelastic, Hertzian-contact & wave-eq. theory to measure & interpret time-dependent principal-strain differences in low-Y* strain-birefringent epoxy plate indented by Mason-horn's wedge-shaped-tip osc. at fixed stroke $2u_o$ as 90kHz CW dipole *line* source obeying Hooke's law. Isolated near- & far-field effects; meas. far-field creep compliance J(t), linked it to const.-strain (stress-relaxation) modulus Y(t); softened Y(t); left residual strain; found effects from |shear stress|$\geq 10^3$ (critical |shear stress| meas. by JA**R** for erythrocyte damage), so proposed SSMSS MUBEM.

1974—1975 **MPL/AFCRL, Hanscom AFB, MA: G_{33}, G_{21}, G_{23}.** NRC postdoc; advisor, Dr. P.H. Carr. From Sm/Co magnets, flat cable & theory of RBT [p.10], invented *compact* EMATs of phased end-fire arrays of RF-eddy-current *line* sources for noncontacting Lorentz-force transduction of pulsed MHz-Rayleigh waves on metal parts for aircraft NDT/avionics. 2 US patents, 10 papers.

1996—1996 **Univ. of New Mexico (UNM), Los Alamos:** Passed Japanese courses; in Japan did home stay & toured nuclear res. labs.

2007—2011 **Dartmouth College** ['07-'11, p.2]**: G_{13}.** Proposed new NMR effects. Ex: Magnetization $\mathbf{M_o}$ of equil. population of nucl. spin-½ systems precessing about *longitudinal* DC magnetic induction $\mathbf{B_o}$ is tipped by FID $\mathbf{B_1}$ pulse to **M** by torque density $\mathbf{M_o x B_1}$, to become $\mathbf{M'=M-v x P}$ as dielectric sample of polarization **P** moves at uniform velocity **v** by RF coil in rest frame X_o. Zeeman-energy shift $=(\mathbf{M-M'})\bullet\mathbf{B_o}$, with $\mathbf{M'}/|\mathbf{M'}|$ tip on unit sphere in X_o Euler-angle coordinate system nutating about **M**-Parallel.

Definition: Disability of person is physical &/or mental impairment of KSA set or record of such, substantially limiting at least one major life activity like thinking, learning, writing or working in prof./personal life, worsened by no reasonable accommodation; discrimination; layoff; long-term unemployment, loss of career [29 CFR 1630.2; ADA/ADAAA, p.8].

Disability Disclosure: First major depression onset of HMF was as **undergraduate student** in late summer of **'63** just before his senior year at UVM, ending with full recovery in **'66** on active duty in USAR at WSMR. *Post-Ph.D.* history incl. baseline + 2 later periods as LANL **worker**, starting with major depression crisis in late **'89** (self-disclosed **'90**):

(I) Late '74–Late '89, high-functioning post-Ph.D. baseline as exp. solid-state physicist (Late '84-Late '89, at LANL). **FT paid work:** 97% of period. **Output:** 1 book ch., 2 bk. articles **+** 11 peer-reviewed R&D journal papers (six, HMF lead author) [pp.4-5] **+** 3 U.S. patents [p.2] **+** dozens of DOE reports & presentations – a low rate relative to top peers.

(II) Late '89–Early '05, 3 depression *onsets → 3 voluntary approved leaves of absence [LOAs] from LANL*. **FT/PT work paid by employers:** 40% of period. **09/95:** HMF as perm. Staff Member (SM) told he was on ESA-Div RIF list with 2½ mo to get directed transfer at LANL; unable to do so after >30 job bids, so let go **11/95**; then unemployed 3yr save ½yr PT contract work [**'95-'97**, p.3]. 3yr total of LOAs for med. treatment of **work-stress-related** mental disability: 1st **01/90-06/90,** 2nd **07/91-07/92**, both for depression as *perm*. SM; 3rd **06/99-01/01** for depression/anxiety as *term* SM **12/98-01/01**. Most LOA time paid by disabil. insurance income ending **05/08** on retiring via UCRP. RIF linked to 1st 2 LOAs in **'96** grievance hearing by panel of 3 LANL peers showing HMF was blacklisted on stating in **04/95** moral *preference* to ESA-MT manager to not work on nuclear bomb to avoid repeat hi-stress response to unexpected encounter with Pu pit when helpful boss retired [WM**M**, p.10]. **Output:** 4 journal papers [p.5]; 0 patents; 24 reports/talks.

(III) Early '05–Present, depression free, blooming late as mathematical physicist. **Paid work:** 0% of period. **Output:** No journal papers; 1 book article, 13 reports, 3 talks. Yet >50 blog comments & online Letters to Ed. arguing for better inclusion in workplace and prof. societies of STEM persons with disabilities, published by groups like AAAS, ACS, APS, IEEE, NAE **+** serials like *Journal of Ethics in Mental Health, Physics Today*, *Profiles in Diversity Journal* and *The Institute* [2nd "various," Service exs, p.2; #13, p.6]. Output *quantity* down via obsolesced PC/Internet tools and loss of research coworkers, funding, and voice for own findings, via >25yr of wear-and-tear from disability-based discrimination. But output *quality* at career high, as by thinking better to solve problems via. math. ideas tied to physical reality/societal need, and trusting his conscience more.

Context for HMF's Disability, Discrimination & Losses: Some employees disclosing personal ethics contrary to LANL senior management view of moral supremacy of nucl. weapons were punished as chronicled in Chuck Montaño's book, *Los Alamos--A Whistleblower's Diary*, 382 pp. softcover (Desert Tortoise Publishing LLC; Santa Fe, NM, **'15**).

* Most acronyms/abbreviations & some symbols in CV (e.g., **F** or Y) listed/defined on pp.8-9; G_{ij} defined on p.7 in *Table* for "GREST" concept.

POST-PH.D. RESEARCH POSITIONS, with G_{ij}, ACHIEVEMENT & DISABILITY-IMPACT EXAMPLE'S*

1974—1974 **Res. Assoc., Physics Dept, UVM: G_{21}, G_{23}.** Calculated elastodynamic-wave losses in solid waveguides. Supervised by WLN & Middlebury College (MC) Physics Dep't Chair Prof. Robert K. Gould, chaired bioacoustics seminars at UVM & MC venues.

1974—1975 **Postdoc, MPL: G_{21}, G_{23}, G_{33}.** Invented narrowband SAW EMATs ['74-'75, p.1]. Papers [4 on p.4]; 2 U.S. Patents ['78, '83; p.2].

1975—1977 **Health Physicist GS-13, Biol. Effects Div/BRH/FDA/DHEW, Rockville, MD: G_{21},G_{23},G_{31},G_{33}.** Invented hydrophones [#5, p.4, with H.F. Stewart]; supported *in vivo* MHz acoustic bioeffects res.; designed IR imager to view ultrasonic dental-scaling heating.

1977—1981 **Res. Associate, NDT Lab Founder & PI; ARL, Penn State: G_{33}, G_{21}, G_{23}** ['77-'81, p.3]**.** Invented wideband EMATs for *in situ* guided elastodynamic-wave NDT/QA of MMC wire made in OH pilot-scale plant (US Patent 4380931, filed 04/81). With Physics Assoc. Prof. R.W. Reed, advised theses [#7, p.4; RH**G**, p.10]. With Math Prof. G.E. Andrews, calc. ultrasonic horn impedance.

1981—1983 **Chief Physicist: R&D Dep't, EHV Weidmann Industries, Inc., St. Johnsbury, VT: G_{31}, G_{33}.** Produced final EPRI report on pilot-scale manufacture via Swiss collaboration of chemically modified cellulose insulation for HVDC transformer use [#5, p.5].

1984—1995 **LANL Permanent Staff Member (PI): G_{ij}.** ER/DOE & LDRD project exs: Discovered neutron rad. doubles MMW dielectric loss in Al_2O_3 ceramic **+** dev. *in situ* tools to meas. damage evolving in ceramics during sintering or proton-irrad. 5 *JNM* papers, 13 FRM report articles. 12/89 disability onset + 07/91 repeat led to 1½ yr LOA linked to termination [period II, *Disabil. Disclo.*, p.1].

1996—1997 **LANL contractor, Comforce Tech. Services: G_{21}, G_{23}.** JJ**C** [p.10] hired HMF 02/96 to run FY96 EM/DOE LDRD proj. HMF proposed as PI in ESA Div *before* layoff. TCE bolus injected, then diffused to spot in wet sand in ultrasonic cleaner sampled for TCE conc. C(t) vs. time t meas. by column chromatography. Ultrasound increased C. Proj. modified in FY97 but HMF left out.

1998—1999 **Term (2yr) Staff Member ($90k/yr), LANL RANT Facility: G_{1j}.** Trained in γ-ray spectroscopy of TRU/low-level nucl. waste via NaI detectors, MCA, laptop computer, software. Counted α particles from Pu contaminating Pt scrap for reclamation purposes.

1999—2005 **See above:** Work stress led to 06/99 request on own for help from EAP [p.8] but with unexpected relief from duty precipitating depression repeat [3rd LOA, period II, *Disability Disclosure*, p.1]. Self-guided Voc Rehab **+** stress-reducing moves incl. 05/00 return to VT; formally terminated 01/01 by LANL at term end. By 04/05 HMF had restored ability to do ER* [e.g., #4, p.6 + next].

2005—2007 **Res. Associate (unpaid), UVM Physics Dep't: G_{21}.** Appointed after 6yr of no work [after 3rd LOA, per. III, *Disabil. Disclo.*, p.1]. With WLN, HMF dev. nonlinear eqns for ultrasound-induced ARF on biomolecules in H_20; coauthored his invited talk [#6, p.6].

2007—2011 **Visiting Scholar (unpaid), Chem. Dep't, Dartmouth College, Hanover, NH: G_{13} & G_{31}.** Used classical electrodynamics & special relativity to model Lorentz-covariant nuclear spin magnetization & Zeeman energy perturbed by electric fields in uniformly moved dielectric test sample; predicted spin-½ system dynamics for graphane & ^{1}H-doped graphene NMR [#7,9,12; p.6].

2010—2014 **President, Frosty's Physics, LLC, Sheffield, VT: G_{21}, G_{23}.** In *pro bono* follow-up on own Ph.D. thesis [#2, p.6], dev. theory for new MUBEM, solid-state mech. shear-stress [SSMSS, p.9 **+** #14, p.6]. Urged more disabil.-based STEM D&I [# 8,13; p.6].

FELLOWSHIPS, HONORS, AWARDS, PATENTS, SPECIAL INCOME, MEMBERSHIPS, PROF. SERVICE

1959 **Honorable Mention** in NH Division of Westinghouse National Search for Talent Contest (which preceded Intel contest) as high school student in Hanover, NH, with invitation to evening lecture of Prof. Francis Sears in Physics Dep't at Dartmouth College.

1962–1962 **Summer Fellow**: Biochem. Dep't, DMS, Dartmouth College, Hanover, NH. Via DC conductivity method, measured CMC transitions of long-chain dicarboxylic acids as ionic surfactants in aq. solution; gave talk on results. Advisor: Prof. Arnold Wishnia.

1966 –1967 **Army Commendation Medal** [via FE**C**, p.10], AMTED QA Office, WSMR, NM: HMF wrote, staffed & fielded SOP to improve field engineer compliance with periodic service needed per calibration stickers on >10^3 Range test instruments. No. of required returns of instruments to NBS-based calibration lab at WSMR then rose by 15% in 1yr, per computer analyses of return rates.

1967–1974 **G.I. Bill Monthly Income** (per Servicemen's Readjustment Act of 1944 **+** Readjustment Assistance Act of 1972), when HMF, now a veteran, was in graduate school at UVM. Program was administered locally by VA Center in White River Junction, VT.

1970–1974 **Hood Interdisciplinary Fellowship**, UVM Physics Dep't: Pre-doctoral award funded by nonprofit Charles H. Hood Foundation, supervised by WLN. It helped HMF work FT on physics dissertation [#2, p.6, spawning papers over '71-'14 in 3 ASA, 1 APS & 2 Ultrasonics Int. meeting talks, associated conf.-proc. papers & corporate tech. reports]. Award eligibility required physics M.S.

1977–1981 **Internat'l Advisory Editor:** *Ultrasonics J.* Nominator: WLN. Annual trips to Europe for Board meetings, Ultrasonics Int. confs.

1978, 1983 **3 U.S. Patents:** EMAT's for ultrasonic elastodynamic wave NDE/T; abstracts at: **patents.justia.com/inventor/harold-m-frost**.

1979–1979 **Guest Scientist:** Polish Academy of Sciences; visited Warsaw, Krakow & Frederick Chopin birthplace. Host: Dr. J. K. Zieniuk.

2007–2008 **UCRP Pension Income Restored:** In 12/07 HMF rec'd notice from UCRP middle manager his pension income would be cut to ~1/3 of his long-term disability income at federally req. transition to retirement. On appeal, UC President (& NAS member) R.C. Dynes in '08 reversed decision, restoring HMF's income, crediting his yrs on long-term disability as service time accrued.

various **Memberships: IEEE Life** since **'09**; **ISMNI Hon.** since **'06** (as son of co-founder Harold M. Frost, MD). **Past IEEE:** EMBS, MTTS, NPSS, UFFCS. **Other Past:** AAAS, ACS, AIUM, Am Cer Soc, APS, ASA, ASNT, ISMRM, Mat'ls Res Soc, Sigma Xi.

various **Service exs:** Led sci. conf. sessions in US, Europe, Asia; **'78-'89**. Gordon Res. Confs. (GRCs) incl. '***09*** *Magnetic Resonance*. Nominated mentors for awards, **'09-'15**. Gift to UVM to plan **'09** symp. in honor of WLN; wrote his **'12** NAE mem. tribute [#7, p.5]. Gave to Dartmouth College, **'04-'14** [e.g., N**M**, p.10] and LANL Foundation **'12-'15**. ***Urged*** educators, employers, prof. non-profits, world bodies (AAAS, ACS, AIP, IEEE, LANL, NAE, OPM, UVM, WHO) to increase disability D&I by recapturing STEM leaders as **late bloomers** isolated from mainstream via major disability acquired and self-disclosed at mid-career, ***as by*** > 50 comment responses (**'08-'15**) to STEM blogs [exs: search "Harold M. Frost III" at **engineeringchallenges.org** (7 results) and at **physicsfrontline.aps.org** (2 results), or browse at **theinstitute.ieee.org/opinions** [15 results + Letters like #13, p.6].

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GREST EXPLORATORY-RESEARCH PROJECT PEOPLE, FUNDING & OUTCOME EXAMPLES (1971 – 2014)*

1971–1974 **Prof. Wesley L. Nyborg, PI [WLN, p.10].** UVM Physics Dep't. His NIH Grant GM-08209 partly supported HMF's physics dissertation res. FT on resonant ultrasonics (incl. photoelasticity to image strain fields) completed in '74 with WLN as advisor.

1971–1974 **Prof. A. D. Crowell,** UVM Physics Dep't Chair. Recommended Hood Interdisciplinary Fellowship inaugural award to HMF of ~$5100/yr for tuition, travel & stipend to cover part of research for dissertation advised by WLN, both signing it on 08/30/74.

1974–1975 **Dr. Paul H. Carr (PI), Branch Chief**, MPL, AFCRL, Hanscom AFB, MA. Advised HMF's NRC Resident Res. Associateship funded by AFSC. On PHC's request, HMF changed his research focus from proposed guided ridge-wave delay-lines to more needed Rayleigh-wave NDT devices, resulting in MPL's 1st-time capability to make, test and use EMATs at MHz frequencies.

1975–1977 **Dr. Harold M. Frost, III (HMF), Health Physicist**, BRH, FDA, DHEW, Rockville, MD. Via FDA funding, invented EMAT-like electrodynamic hydrophones as proposed new calibration method for in-house *in vivo* ultrasound bioeffects studies [#5, p.4] **+** designed IR-thermography imaging system for *in vitro* heating from *tangential* EIP by ultrasonic dental scalers [#2, p.5].

1977–1981 **HMF, Project Scientist & PI**, ARL, Penn State. $100k up-front via ARL Director/NSSC blanket contract to found its 1st NDT res. Lab. **1st yr** built up Lab, staffing, contacts. **2nd yr** with moral/logistics support of Prof. Eugen Skudrzyk & Dr. Jan Holland, won as PI $210k/3yr via NSSC PM Dr. M. Kinna to fund tech, physics Assoc. Prof. R. W. Reed & self to improve QA in pilot-scale manufacture of MMC wire; contract monitor, Dr. J. V. Foltz, NSWC. HMF math. derived method proved by data/US Patents to make test signals from noncontacting 4-EMAT arrays (to gen./detect elastodynamic torsional & other waves) not sensitive to variable liftoff. Hosted NSWC scientist A.L. Bertram. Taught Penn State's 1st grad. course in solid-state ultrasonics; wrote EMAT book ch. [1st #2, p.5]; PI for physics M.S./Ph.D. res. in liq.-^{4}He acoustics. RWR became PI when HMF left.

1981–1983 **Heinz Fischer (PI), R&D Dep't VP**, EHV Weidmann Industries, Inc. $500k/4yr EPRI contract (PM, E.T. Norton) funded 10 engineers PT (5 at EHV, 5 at parent Swiss firm, Weidmann AG), incl. HMF writing final report & leading its production team.

Notes: Below are funding history ex's of HMF as permanent Staff Member in LANL MST Div unless otherwise noted. DOE and DoD funding totaled $5M for 15 R&D and related projects, 7 as Project Leader or PI, 5 as Co-PI or Task Leader, and 4 other. He co-generated $3M in funding for project operations & capital equipment acquisitions. In '90 & then '99, HMF lost work status due to major disability onset & med. leave of absence per 3rd, 5th & 10th blocks infra.

1984–1986 **Dr. R.J. Livak (PI),** MST-5 group**.** His ISRD grant funded HMF ½ FTE to measure, analyze & report on high-fluence fast-neutron-induced shifts in DC electrical resistance of 6 Cu alloys for possible MFE 1st-wall use. Publ. papers & DOE reports.

1985 **HMF**, MST-5. Won $130k in MST-DO capital equip. grants for automated scalar-network-analyzer system to meas. MMW dielectric tanδ via *in-waveguide* RT data on insulator ceramics for DOE **+** *free-space* data on Al_2O_3 up to 2000K for DARPA.

1985–1990 **Dr. Frank Clinard, Jr. [FWC, p.10], Sec Ldr (PI; then retired) & HMF (co-PI; then PI)**, MST-5, then MST-4. $300k/yr from OFE for 2-3 PT staff; 2 PT techs; scientists from abroad, for *Dielectric Loss Meas. in Ceramics*. HMF meas. doubling at RT of MMW diel. loss tangent exposed 1yr to fast neutrons in nucl. reactor, as reported by FW**C** at ICFRM-3 ('87, Karlsruhe, W. Germany) **+** HMF at ICRFM-4 ('89, Kyoto, Japan). 5 *JNM* papers, 15 DOE progress reports. FY '86-'88: LANL work under DOE Energy Mat'ls Coord. Committee. Dr. E. Farnum PI in '90, on HMF's 1st LOA from work [Per. II, *Disabil. Disclo.*, p.1].

1986–1987 **Dr. John Petrovic (PI), Sec Ldr**, MST-5. His DARPA proj. for microwave sintering of ceramics gave HMF 0.15 FTE/yr to measure world's 1st openly reported values of *free-space* polarization-dependent MMW dielectric loss in Al_2O_3 at 2000K.

1987–1990 **HMF (PI)**, MST-4. ISRD Project X84T, *Electrical phenomena & microstructural evolution during conv. sintering of ceramics*. $750k/3yr for 7 Staff Members **+** tech's PT. Dev. *in situ* NDT probes & Monte-Carlo simulations of μ-structure evolving in insulating, electronic & HTSC ceramics. HMF hired J.C. Kennedy, III to meas. AC conductivity of HTS (Y-Ba-cuprate) disks heated under O_2. (In '97 JCK earned UNM chem. eng. Ph.D.) 2 journal papers; 10 talks; annual progr. reports. Early '90: Proj. team member Dr. Joel Katz chosen PI on HMF's 1st acute disability onset at work [1st LOA, per. II, *Disabil. Disclo.*, p.1].

1989–1990 **HMF (PI)**, MST-4**.** Won MST-Div 1-yr grant, hired/supervised postdoc H.H. Javadi, past doctoral student of colleague Prof. George Grüner, UCLA Physics Dep't. MMW properties of thin-film HTSCs meas. at ~4K. 2 papers publ. HHJ now at JPL.

1992–1994 **Dr. Stephen Agnew (PI),** INC-4, then CST-4. His EM/DOE project funded HMF in MST-4, then WX-3 via directed transfer & ESA-2 after reorganization as FT test-site supervisor to dev. alternative hi-power ultrasonics mixing tech. to lower detonable H_2 built up by radioactive decay in Hanford hi-level nuclear-waste underground storage tank. Talks, demos, invention-disclo.

1993 –1995 **HMF (PI)**, WX-3, reorganized to ESA-2, then ESA-MT. With LAMPF/Free-Electron-Laser staff, proposed new 3yr LDRD proj. hypothesizing stress in thick steel & Pu parts analyzable by γ-ray stress birefringence/dichroism as photoelastic analogue; invention disclosed [WM**M**, p.10]; 3 LDRD proposals unfunded. Despite forced office moves & RIF, 4th LDRD project proposal funded [next].

1995–1997 **HMF (PI), then Dr. John Coogan as PI [JCC, p.10],** CST-18. After late '95 layoff, HMF still won $60k from DOE/EM for his *pre-layoff* FY96 (4th) LDRD proposal for ultrasonic removal of TCE from simulated soil – an outgrowth of his earlier EM PD under WM**M** [p.10]. Due to no power ultrasonics expert now at LANL, HMF was rehired by JJ**C** in 02/96 as Comforce contractor employee to start & supervise project work. LANL policy prevented contractor employee from being PI, so JJ**C** was. HMF's talks & FY96 annual report revealed data good enough to continue project into FY97, when HMF was cut from work.

1998–1999 **Dr. Stephen Betz, Sec Ldr**, CST-7. As 2-yr at-will term Staff Member ($90k/yr), HMF trained at RANT to do γ-ray spectroscopy of low-level nucl. waste in sealed drums as member of NDA team sending Nation's 1st TRU shipment 03//99 to WIPP. In 06/99 on own HMF sought EAP aid to lower stress response to fast operations pace, shared office, hi-rad. environment, heavy DOE oversight – but, barred in 09/99 from duty, suffered depression repeat [3rd LOA, period II, *Disabil. Disclo.*, p.1].

2010–2014 **HMF** managed Frosty's Physics, LLC (scientific consulting firm), Sheffield, VT [# 9-12, 14; p.6]. Dev. theories for new med. ultrasound bioeffect mechanism, solid-state mechanical shear-stress [SSMSS & Y, p.9] **+** NMR interaction [#7,9,12; p.6].

* Most acronyms/abbreviations & some symbols in CV (e.g., **F** or Y) listed/defined on pp.8-9; G_{ij} defined on p.7 in *Table* for "GREST" concept.

PEER-REVIEWED JOURNAL PAPERS on GREST:* EXPOSIMETRY & NDT&E with G_{ij} EX'S (1976-1994)

Notes: HMF's work locations, project funding sources & G_{ij} values for ER results reported in papers cited here are: MPL/AFCRL, AFSC & NRC ***(G_{21}, G_{23}, G_{33})*** *for (1) - (4); BRH/FDA/DHEW* ***(G_{21}, G_{23}, G_{31}, G_{33})*** *for (5), ARL/Penn State & NSSC* ***(G_{33}, G_{21}, G_{23})*** *for (6), ARL-&-Physics-Dep't/Penn State & NSSC* ***(G_{31}, G_{33})*** *for (7), and MST-Division/LANL & ER/DOE* ***(G_{11}, G_{12}, G_{13}, G_{21}, G_{23}, G_{31}, G_{33})*** *for (8) - (15).*

(1) Frost, H.M. and Szabo, T.L. **(1976)**. "Surface acoustic wave electromagnetic transducers from flat cable (multiconductor)." ***Applied Physics Letters*** *29*, 73-75. Noncontact elastodynamic NDT of metal surfaces by *compact/low-cost* EMATs to gen./receive Rayleigh waves.

(2) Szabo, T.L. and Frost, H.M. **(1976)**. "SAW electromagnetic transducer design for nondestructive evaluation applications." ***IEEE Trans. Sonics Ultrason.*** *SU-23*, 323-328. Theory/exp't for handheld EMAT prototypes, toneburst at 1-2MHz for Rayleigh-wave NDT&E of metals.

(3) Sethares, J.C., Frost, H.M., and Szabo, T.L. **(1977)**. "Fields of flat conductor electromagnetic surface acoustic wave transducers." ***IEEE Trans. Sonics Ultrason.*** *SU-24*, 88-94. Fourier analysis of spatial harmonics of RF magnetic fields of meander/grating line arrays as coils of EMATs to generate/detect Rayleigh-wave toneburst s (1-2MHz) on metal surfaces incl. effects of transducer geometry, liftoff & inductance.

(4) Frost, H.M., Sethares, J.C., and Szabo, T.L. **(1977)**. "Rotation sensing through electromagnetic-surface-acoustic-wave transduction." ***Journal of Applied Physics*** *48*, 52-58. Model based on standing MHz Rayleigh waves on surface of Al cylinder rotating under stationary transmitter/receiver pair of curved EMATs in large electromagnet bore. Data taken by HMF. Rotation rate sensitivity 10^3 times > that calc. for piezoelectric SAW-sensor designs. Geophysics & inertial guidance applications. U.S. Patent 4,126,047 (with J. Sethares) ['78, '83 line, p.2].

(5) Frost, H.M. & Stewart, H.F. **(1978)**. "Lorentz force hydrophones at megahertz frequencies: theory, practice & applications." ***Ultrasonics*** *16*, 11-20. Designed & tested prototypes of inverse-Lorentz-force hydrophones of meander/grating line arrays submerged in H_2O near Sm-Co magnets to: (1) Detect/calibrate MHz acoustic beams from piezoelectric projectors used in animal exposure studies & (2) meas.(in H_2O) reflection coefficients. Based on idea HMF dev. at AFCRL, then shared with WLN at UVM in '77 before BRH work. Trained HMF for (6) next.

(6) Frost, H.M., Prout, J.H., and Reed, R.W. (RWR) **(1982)**. "Torsional velocity measurements in wire, with application to metal-matrix composites." ***Journal of Applied Physics*** *53*, 4218-4225. Res. at ARL/Penn State with impulse-excited guided-elastodynamic-wave 1D NDT scans of Al/graphite-fiber MMC wire, with pulse center frequencies >100kHz. 3-EMAT array use gave accurate/precise velocity data point by point along wire length as confirmed by 1% agreement of meas. vs. reported value of elastic constant C_{44} for graphite fiber. Paper prequel to '83 US Patent 4,380,931, *Apparatus and Method for Quantitative Nondestructive Wire Testing* (HMF, J.H. Prout, R.W. Reed) providing accurate/precise way to measure wave attenuation as 2nd improved metric for MMC wire quality ['78, '83 line, p.2]. A 4-EMAT design HMF math. modeled in Patent, to remove unacceptable changes in sensor output voltage vs. wire coordinate when random roughness in MMC wire surf. caused inadvertent wire-coil liftoff (& ∴ voltage) variation typical for 1D scans from 2-/3-EMAT arrays, was incl. in his plan to apply 4-EMAT arrays to ext. waves in wire **+** Lamb waves in plates. Data of RWR as PI after HMF left ARL in '81 fully verified correctness of HMF's theory.

(7) Generazio, E.R., Reed, R.W., and Frost, H.M. **(1983)**. "Interaction of ultrasonic third sound with substrate surface defects." ***Physical Review Letters*** *50*, 174-177. At Penn State, team discovered 3rd sound waves in superfluid ^{4}He thin films *do* reflect from surface cracks as on glass. 1st-time generation/reception of 3rd sound at 200 kHz = 10-fold increase over prior art. HMF gleaned idea of 3rd sound reflection from acoustic impedance discontinuities in superfluid ^{4}He thin films by being at Penn State Physics Dep't seminar of (then Ass't) Prof. Julian Maynard on liquid-^{4}He acoustics; physics theorist Prof. Milton Cole urged HMF to pursue it. Physics Dep't Chair Prof. R.H. Good [p.10] gave HMF space in Davey Hall to do expts to test idea, leading to collaboration with Assoc. Prof. R.W. Reed. Via ARL's Dr. M.T. Pigott, HMF won Navy $ to hire & coadvise grad student ER Generazio to do research, earn Ph.D., publish papers and have distinguished NASA NDE career.

(8) Livak, R.J., Frost, H.M., Zocco, T.G., Kennedy, J.C., and Hobbs, L.W. [LW**H**, p.10] **(1986)**. "Promising copper alloys for high heat load application in neutron environments." ***Journal of Nuclear Materials (JNM)*** *141-143*, 160-162. Six Cu alloys in fast-neutron irradiation study at LANL were high-heat-flux-tolerant candidates as 1st-wall heat-shield mat'ls for toroidal MFE reactor designs at the time, like ITER now being built in Cadarache, France. HMF developed figure of merit combining mechanical & thermal properties to rank overall alloy performance.

(9) Frost, H.M. and Kennedy, J.C. **(1986)**. "Porosity swelling and transmutation contributions to conductivity changes in some neutron-irradiated copper alloys." ***Journal of Nuclear Materials (JNM)*** *141-143*, 169-173. At LANL HMF designed 4-point apparatus to measure DC electrical conductivity (DCEC), used mixtures theory to subtract out effects of transmutation products and swelling on post-irrad. DCEC data meas. at room temp. & convert this property to thermal conductivity via Wiedemann-Franz law. He hired statistician to do a formal statistical analysis of data, with one of six candidate Cu alloys thus found to have neutron-fluence induced change of unknown cause in DCEC.

(10) Frost, H.M. and Clinard Jr., F.W. [FW**C**, p.10] **(1988)**. "Dielectric changes in neutron-irradiated RF window materials." ***Journal of Nuclear Materials (JNM)*** *155-157*, 315-318. Pioneering & consequential post-irrad. LANL measurements at RT/90-100 GHz of high-fluence, fast-neutron induced rises in dielectric losses in candidate MFE polycrystalline ceramics, via automated scalar network analyzer system built to HMF's specs by Hughes Aircraft Co. Meas. dielectric loss tangent doubling in Al_2O_3. Multi-year study's data enabled probabilistic failure analysis of scenario of ceramic windows subject to thermal hoop stress on MMW-beam passage thru 1st wall of toroidal MFE reactor for ECRH heating of D-T plasma. Unacceptable decreases predicted in estimated times to failure led res. community to seek other candidate ceramics for application. FWC gave oral paper version at **'87** ICFRM-3 at Karlsruhe, W. Germany; HMF gave sequel paper at *ICFRM-4* [p.8].

(11) Claytor, T.N., Frost, H.M., Feiertag, T.H., Sheppard, A., and Shalek, P.D. **(1989)**. "Nondestructive measurement of microstructure evolution in ceramics." ***Materials Evaluation*** *47*, 532-537. NDT&E at LANL of ceramics emerging as useful DOE/DoD defense-related mat'ls prepared via different green-body chemistry routes: Microfocus radiography, computed tomography, digital thickness gauging, ultrasonic

testing via transmission & backscatter techniques, and *in-situ* MMW detection of cracking in large ceramic disk undergoing sintering. Techniques facilitated by image capture and processing techniques as at high temperatures. Radiation effects types: **G_{21}**, **G_{31}**.* Test data verified W.M. Visscher & HMF's Monte-Carlo Cray-computer simulations of 2D μ-structure evolution incl. computer-gen. movie shown at GRC conf.

(12) Gieske, J.H. and Frost III, H.M. **(1991)**. "Technique for measuring ultrasonic velocity and attenuation changes in attenuative materials at temperature such as during sintering processes." ***Review of Scientific Instruments*** *62*, 3056-3060. PC-based buffer-rod ultrasonic (**G_{21}***) system for automating *in situ* inspection of materials at high temperatures, as successfully employed to measure longitudinal velocity and attenuation changes at 5 MHz during sintering of ZnO-based varistor materials and $YBa_2Cu_3O_x$ superconducting (HTS) ceramics. JHG (Sandia National Labs., Albuquerque) was funded by LANL contract via HMF's LANL ISRD project X84T, FY87-FY90 [1987-1990 block, p.3].

(13) Mollá, J.; Ibarra, A.; Frost III, H.M.; Clinard Jr., F.W. [p.10]; Kennedy III, J.C.; and de Castro, M.J. **(1991)**. "The effect of ZrO_2 doping on mechanical and dielectric properties of Al_20_3 and $MgAl_2O_4$***." Journal of Nuclear Materials (JNM)*** *179-181*, 375-378. 1st, 2nd and last co-authors from Spain in internat'l scientific collaboration arranged by FWC. HMF took in-waveguide dielectric loss data at 90-100 GHz and room temp., provided math. algorithm to JCK who coded it to computer-automate data reduction/display of dielectric constant & loss tangent.

(14) Farnum, E.H., Kennedy, J.C., Clinard, F.W. [p.10] & Frost, H.M. **(1992)**. "Radiation-induced conductivity in alumina from 100 Hz to 10 MHz during proton irradiation." ***Journal of Nuclear Materials (JNM)*** *191-194*, 548-55. *In situ* data taken at LANL's Ion Beam Materials Lab on single-crystal sapphire specimens, each **(1)** configured as guard-ring capacitor connected to automated impedance analyzer (capital equip. in HMF's earlier ISRD Project X84T ['87-'90 block, p.3]) and **(2)** irrad. with 3 MeV protons passing thru sample mounted on Cu-block heat- sink beam-stop. Immediate rise in tanδ from c.10^{-4} to >1 due to balancing rates of forming electrons/holes & trapping/annihilating them.

(15) Birch, J. R., et al. (incl. Frost, H.M. and Vigil, R.S. at LANL) **(1994)**. "An intercomparison of measurement techniques for the determination of the dielectric properties of solids at near millimetre wavelengths." ***IEEE Transactions on Microwave Theory and Techniques*** *42*, 956-965. Global effort of 22 authors with round-robin sample exchanges coordinated by Dr. J.R. Birch, National Physical Lab. (NPL) in Teddington, Middlesex, England that in **1990** published 233p. final report (NPL TR DES 115) with same title & co-authors. As part of project, HMF attended and presented his LANL MMW data at earlier workshop in Durham, England organized by Dr. Birch.

EX'S of ARTICLES, CHAPTERS & OTHER in BOOK-LENGTH PUBLICATIONS (excl. prof. conf. proc.):

(1) Frost, H.M. and Szabo, T.L. **(1975)**. "Transducers applied to measurements of velocity dispersion of acoustic surface waves," paper 48, pp. 429-450, *AFML Technical Report AFML-TR-75-212*, AFML, Wright-Patterson AFB, Dayton, OH. HMF gave paper at ARPA/AFML Review of Quantitative NDE, Thousand Oaks, CA, **July 1975**. Demonstrated superiority of noncontacting EMATs over wedge and comb transducers for pulse overlap techniques. In early 1980's, Plenum Press started publishing reports as annual proceedings [viz., #7 *infra*].

(2) Frost, H.M. (**1978**). "Heating under ultrasonic dental scaling conditions," pp. 64-74 in *Symposium on Biological Effects and Characteristics of Ultrasound Sources*, Proc. of Conf. in Rockville, MD , June 1-3, 1977; HEW Publication (FDA) 78-8048. Suggests meas. excessive heating & mech. effects like "gouging" & "scratching" linked to abusively operated ultrasonic dental scalar (UDS) to assess its possible hazard. This includes noncontact methods such as optical meas. of UDS tip stroke amplitude and infrared scanning ("Thermovision") setup.

(3) Frost, H.M. **(1979)**. "Electromagnetic-ultrasound transducers: Properties, methods, and applications." Ch.3, pp.179-275 in *Physical Acoustics*, **vol.14**, W.P. Mason & R.N. Thurston, editors (Academic Press, New York). 2nd of 3 EMAT chapters in this book series.

(4) Tucker, D.S.; Vaniman, D.T.; Anderson, J.L.; Clinard, Jr., F.W.; Feber, Jr., R.C.; Frost, H.M.; Meek, T.T. and Wallace, T.C. **(1985)**. "Hydrogen recovery from extraterrestrial materials using microwave energy," pp. 583-589 in *Lunar Bases and Space Activities of the 21st Century*, W.W. Mendell, ed. (Lunar and Planetary Institute, Houston, Texas, **1985**). Corresponding paper presented at NASA-sponsored symposium hosted by the NAS in Washington, D.C., **October 29-31, 1984**. Full text of paper via: **ads.harvard.edu/books/lbsa/**.

(5) Fischer, H.G.; Fried, K.L.; Frost, H.M. (writer & producer); Fuehrer, R.; Stowe, W. C.; Taylor , L.; Brupbacher, P.; Dahinden, V.; Friederich, H.; Hummel, H. and Moser, H.P. **(1985)**. *HVDC converter transformer insulation*. Final Report EPRI-EL-4004, Project 1424-1 (EPRI, Palo Alto, CA), 494 pp. Full text via: **www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=EL-4004**.

(6) Frost, H.M. et al. **(1986)**. 4 ex's of HMF's DOE report contributions: **Nos. 1.5** (pp.18-21), **8.1** (pp.401-405), **8.2** (pp.406-407) & **8.3** (pp. 408-416) in *Fusion Reactor Materials Semiannual Progress Report* for period ending Sep 30, DOE/ER-0313/1 (Washington, DC: DOE), with LANL co-authors F.W. Clinard, Jr. [p.10], C.D. Kise, A.C. Lawson & T.G. Zocco + N. Iwamoto (Osaka University) & L.W. Hobbs [MIT; p.10], with titles: **1.5**, "Capability for Measuring MMW Dielectric Proper-ties in Free Space and at Elevated Temperatures"; **8.1**, "In-Waveguide Measurements of MMW Dielectric Properties of Candidate Fusion Ceramics;" **8.2**, "Properties & Radiation Resistance of the Candidate RF Window Materials SiC & Al_2O_3;" and **8.3**, "On Neutron-Induced Damage to the MMW Dielectric Properties of Alumina." These & other ex's are archived full-text at: **web.ornl.gov/sci/physical_sciences_directorate/mst/fusionreactor/semiannual.shtml**.

(7) Gieske, J. H. & Frost, H. M. **(1989)**. "Sound Velocity Measurements in Green-Body Ceramics **as** a Function of Sintering Temperatures," pp. 1709-1716 in *Review of Progress in Quantitative NDE*, **Vol. 8B**, edited by D.0. Thompson & D.E. Chimenti. (Plenum Press, New York). Sintering process probed *in situ* by 5-MHz ultrasound-wave buffer-rod technique for facilitating velocity and attenuation measurements.

(8) Frost, III, Harold M. **(2012)**. "Wesley L. Nyborg: 1917-2011," pp.196-205, *Memorial Tributes*, **Vol.16** (NAP, Washington, DC). Invited by NAE to write draft incl. family input. Used article to promote recognition of WLN as bioacoustics pioneer. Full text via **www.nae.edu**.

OTHER ER* on BIOEFFECTS, EIP,* MATHEMATICS, NDT & NMR + ADVOCACY for BETTER D&I

(1) Frost, H.M. **(1969)**. *Interactions between a vibrating object & the surface of a soft solid*. M.S. thesis, UVM Physics Dep't, advisor WLN. Experiments in EIP [p.8]: Depth-vs.-time data from DC displacement transducer for 20kHz Mason horn tips of diff. shapes penetrate solids (gel; wax; Pb) with tissue-like Y values, under creep loads **F_s**. Abstract via search on Frost at: **www.brl.uiuc.edu/Abstracts**. Prequel to next.

* Most acronyms/abbreviations & some symbols in CV (e.g., **F** or Y) listed/defined on pp.8-9; G_{ij} defined on p.7 in *Table* for "GREST" concept.

(2) Frost, H.M. **(1974)**. $\mathbf{G_{2j}}$.* *Action of ultrasound on a viscoelastic solid*. Ph.D. dissertation (335 pp.), UVM Physics Dep't. Advisor: WLN. Abstract: **library.uvm.edu/dissertations/?search_type=item&bid=6053**. In HMF's res. on physics of EIP [p.8] cont'd from M.S. thesis *infra* [p.5], localized static & dynamic creep line forces ($\mathbf{F_s}$ & $\mathbf{F_d}$) from Mason-horn tips oscillating at fixed tip displacement amplitude u_o & indenting edge surface of viscoelastic epoxy plate, set up ultrasonically time-ave. in-plane intermittent contact forces obeying Hooke's law at intermediate values of u_o + continuous contact forces yielding nonlin. effects at lower & higher values of u_o + time-dependent contact area, strain field & creep compliance. Effects analyzed by transmission photoviscoelasticity, self-excited resonant ultrasound spectroscopy & diagnostic exp'ts to separate thermal & nonthermal effects. Prequel (same title; WLN as co-author): *Ultrasonics International 1973 Conference Proceedings*, pp. 81-88 (IPC Science & Technology Press Ltd., Guildford, Surrey, England, **1973**). Theses + sequels [#6,10,4; p.6] bear on ARF-based ultrasound-imaging like ARF impulse or step; vibroacoustography; static, quasistatic or MRI elastography; shear-wave elasticity; supersonic shear; or on more traditional echogenic imaging enhanced by ultrasonic contrast agents. In HMF's new MUBEM, solid-state mechanical shear stress [SSMSS, p.9], $\mathbf{F_s}$ can be equivalent to ARF, $\mathbf{F_d}$ to instantaneous force, as in medical ultrasound imaging of patients.

(3) Frost, H.M. & Stratmeyer, M.E. **(1977)**. Letter to Ed., "In-vivo effects of diagnostic ultrasound;" $\mathbf{G_{21}}$, $\mathbf{G_{23}}$.* *The Lancet* **309** (No. 8019): 999 (May 7); 1st publ. as Vol. 1, Issue 8019. Survey of known mammalian central-nervous system bioeffects (when HMF worked at FDA).

(4) Frost, H.M. **(2005)**. "The golden ratio, irrationals, sequences and the parabola." Hour-long seminar, April 26, Math. Dep't, Lyndon State College, Lyndon, VT. Returned [via DC**M,** p.10] to doing exploratory research (ER*), now in analytic number theory after 6 yr of recovery from, then growth as mathematical physicist after major disability onset recurred in 1999 [3rd LOA, period II, *Disability Disclosure*, p.1].

(5) Frost, H.M. **(2005)**. "Past and future of ultrasonic indenter physics and engineering at UVM, including new research directions & possible clinical applications for bone." UVM Physics Dep't Colloquium, Dec 14. Med. diagnostic idea of orthopedic "indentoscope" based on HMF's physics dissertation [#2, p6] + 4-EMAT method of U.S. Patent 4,380,931 [#6, p4] applied to ultrasonic guided waves in long bone.

(6) Nyborg, W.L. & Frost, H.M. **(2006)**. "Stress, strain & flow produced by a vibrator in or on the surface of a soft solid." Talk (invited) in session honoring Prof. Edwin L. Carstensen (University of Rochester), 151st ASA Meeting, Providence, RI. Based on HMF's dissertation [#2 *supra*], applied to biomedical ultrasound field. Online abstract: **scitation.aip.org/content/asa/journal/jasa/119/5/10.1121/1.4786586**.

(7) Frost, H.M. **(2007)**. "Beginning of a New Way of Looking at Nuclear Magnetic Resonance," 31pp., Aug 16, unpublished. Theoretical white paper on NMR with key hypothesis borrowed from physical chemistry fundamentals that magnetization of interacting spin systems is directly proportional to fugacity, reducing to spin pressure at low values in ideal gas limit. Adds new term to vector form of Bloch equation.

(8) Frost, H.M. **(2008)**. "New Learning Model for Struggling Students in STEM Educational System," 67pp, Dec 19. White paper based on logical if/then reasoning sequence of identity, idea, inquiry, invention, innovation & importance concepts; vetted with NM education experts.

(9) Frost, H.M. **(2010)**. *Solid-state NMR with dipolar interactions – A new look at the ground state when the sample is moved*, 16 pp, Oct 23. *Pro bono* TR 2010-3, Frosty's Physics, LLC. Analysis based on HMF's Double Hypothesis Algorithm [ER, p.8]. Includes MRFM of nanoscale electric-field gradients in graphane & ^{1}H-doped graphene. Has biomedical and NDT imaging applications.

(10) Frost, H.M. **(2011)**. *Contact Mechanics and Dynamics of a Special Type of Vibrating Indenter Acting on a Soft Solid*, 11 pp., May 9. *Pro bono* TR 2011-1 (ver 04), Frosty's Physics, LLC. Abstract: **www.brl.uiuc.edu/Abstracts**. Extends HMF's dissertation [#2, p.6] on physics of EIP [p.8] on way to proposing new MUBEM, SSMSS [p.9]. Derived nonlin. laws between ultrasonic forces & contact stresses (incl. time-ave.) for both continuous & intermittent contact. Pairs of intermittent-impact forces to break/re-store contact in 1 cycle assumed to obey $\mathbf{IF_B}=-\mathbf{IF_R}$, with 0 time ave. In sequel, extended SSMSS work to incl. case of $\langle \mathbf{IF_B}+\mathbf{IF_R} \rangle \neq \mathbf{0}$ when creep compliance J(t) is used in calc.

(11) Frost, H.M. **(2011)**. *Methodology for Generating New Integer Sequences Including a Recursion Relation*, 14 pp., July 31. *Pro bono* TR 2011-2, Frosty's Physics, LLC. Invented new infinite sequence of primes by topologic method of removing terms from known one; 1st added in 2007 to *Online Encyclopedia of Integer Sequences*. Text for it and its revisions at: **oeis.org/A133257.**

(12) Frost, H.M. **(2011)**. *Roadmap for Scientific Research to a New Paradigm for NMR and MRI Sensitive to Internal Electric Fields in Uniformly Moving Test Samples*, 80 pp., Sep 21. *Pro bono* TR 2011-3, Frosty's Physics, LLC. Detailed theory in classical electrodynamics.

(13) Frost, III, H.M. **(2012)**. "Suffering Preceded Success." Letter posted online April 9 by IEEE magazine *The Institute* deals with forming own consulting firm, Frosty's Physics LLC, as person with a disability. Full text: **theinstitute.ieee.org/opinions/letters/letter-to-the-editor**.

(14) Frost, H.M. **(2014)**. *Residual stress induced ultrasonically and nonthermally in thin epoxy plates at room temperature and under creep-loading conditions*, 4 pp., Jan 28. *Pro bono* TR 2014-1, Frosty's Physics, LLC. Sequel to #2 &10 *supra*. Residual stresses and strains from *dynamic indentation* [part of EIP, p.8] relate to Y [p.9] via new MUBEM proposed by HMF, solid-state mech. shear stress [SSMSS, p.9].

CONTRIBUTIONS to RESEARCH TRENDS incl. PEER-REVIEWED JOURNAL PAPERS - EXAMPLES

By securing res. funding; making capital equip. purchases; hiring/supervising staff incl. physics Ph.D. candidate, postdoc, assoc. professor & techs; & providing key ideas leading to initial papers, HMF (not co-author) contributed directly to follow-on journal & conf.-proc. papers & progress reports on ultrasonics & EMATs, as by JC Sethares & TL Szabo in *J. of Appl. Physics* **('78)** [building on #3, p.4]; 2 papers by ER Generazio & RW Reed in *J. of Low Temp. Physics* **('84)** [building on #7, p.4]; & via HMF's work at LANL a paper in *Solid State Communications* **('90) +** 2 more on *in situ* nucl. rad. effects on ceramics in *JNM* **('94, '95) +** 10 "Ceramics" articles in *Semiannual Progress Reports*, vols. 11-17 **('92-'94)** at **web.ornl.gov/sci/physical_sciences_directorate/mst/fusionreactor/semiannual.shtml**. Research of HMF as PI led to book papers like "Noncontact Ultrasonic Evaluation of Metal Matrix Composite Plates and Tubes," RW Reed, pp. 216-226, *Testing Technology of Metal Matrix Composites*, ASTM STP 964, ed. by P.R. DiGiovanni & N.R. Adsit **(**ASTM, **'88) +** U.S. Patent No. 4,477,779, Robert W. Reed, inventor (**'84) +** Ph.D. theses in physics & metallurgy. HMF's papers influenced independent U.S. gov't NDT technology reports like NAVSWC Tech. Report 91-446, "A Comparison of Ultrasonic and Mechanical Test Values of the Principal Young's Modulus of Unidirectional Metal Matrix Composites" **('91)** by J. V. Foltz & A.L. Bertram of NSWC. Crossover citation incl. use of HMF's meanderline EMAT coil as NQR coil design per paper in *J. Magnetic Resonance* **('91)**. Useful discussions with HMF were noted in papers as on planetary astronomy in *J. Geophys. Res.* **('87) +** elasticity imaging in *J. Biomech. Eng.* **('07) + '90** paper *supra*. Recently HMF's physics dissertation [#2, p.6] was cited in WLN's Ch.24, "Biological Effects of Sound and Ultrasound,"pp.809-838 in *Handbook of Molecular Biophysics* edited by H.G. Bohr (Wiley-VCH, **'09**). Too, R&D projects/labs of HMF in **'70s/'80s** led directly to dev. new R&D trends in **'90s +** basis for new facilities in **'10s** incl. today's Ultrasonics Lab in Eng. Sci. & Mech. Dep't at Penn State (EMATs for guided-wave NDT; **www.esm.psu.edu/labs/ultrasonics/**) & Matter-Radiation in Extremes experimental facility at LANL (**marie.lanl.gov**).

* Most acronyms/abbreviations & some symbols in CV (e.g., **F** or Y) listed/defined on pp.8-9; G_{ij} defined on p.7 in *Table* for "GREST" concept.

*GENERALIZED RADIATION- EFFECTS SCIENCE & TECHNOLOGY (GREST), with G_{ij} EXAMPLES: **

HMF's 60yr of experience with ER* on GREST* include 3 main radiation types to probe and/or change properties of materials, devices & systems. Published & unpublished ex's in *Table* highlight structure/unity of GREST as framework of physical insight linking early scientific research via simple exp'ts & theories, to early engineering practice of invention/prototypes/tests/validation later advancing eng. fields like aerospace, biomed., EM, ESM, CSE, MS&E, NDT & nucl.

Table: 3x3 Matrix of Examples for 9 Radiation-Effects Cases G_{ij} in HMF's Exploratory Research Career on GREST

Type of Radiation	**Locations of Initiating Radiation Fields and/or Sources Acting on or in Materials (9 G_{ij} categories)**		
	COL. 1: Outside or on Ext. Boundary (ext. irrad.)	***COL. 2: Inside (self-irrad.)***	***COL. 3: Both Inside/Outside***
***ROW 1* Ion/Nuclear** *(particle incl. proton & mol. beams; atomic fragments from nuclear reactions; nucl. Zeeman effects)*	**G_{11}:** Fast neutrons pierce ceramic samples exposed 1 yr in core of Experimental Breeder Reactor EBR-II in Idaho produce point-defect clusters & microvoids that in turn affect post-irradiation values of complex MMW (W-Band) dielectric constant including loss tangent. Beam of 3-MeV protons produced at LANL Ion Beam Materials Lab passes thru thin sapphire samples to produce radiation-induced conductivity as measured *in situ* at different temps. by impedance analyzer freq.-swept from 100 Hz to 10 MHz. Both led to 2 *JNM* papers + DOE reports [#10, p.4 + # 6,13,14; p.5].	**G_{12}:** Nucl. decays rad. α's in ^{238}Pu-substituted zirconolite-based ceramic as trial matrix for hi-level nucl.-waste form subject to α-recoil damage in research of colleague FW**C** [p.10] analyzed to nominate him for important 2010 NPSS Radiation Effects prize [extra *Service* ex. for bottom, p.2 + ER ex.5, pp.33-36, *FP* *].	**G_{13}:** In photoelastic analogue, x- & γ-rays are proposed for analysis of stress per known x-ray birefringence of $LiNbO_3$ + use of polarized γ-rays absorbed or emitted in nucl. reactions like ^{2}H photodissociation & inverse Compton scattering, in unfunded LANL LDRD proposals (3) + DOE invention disclosure that supervisor WM**M** [p.10] urged.
ROW 2* Mechanical: Acoustic** *(in fluids; Y=0; viz., acoustic rad. force) or* ***Elastodynamic *(in solids; Y>0; viz., SAWs; shear or wire waves)*	**G_{21}:** CW or pulsed beam of longitudinal acoustic waves from MHz ultrasound xducer int. exposes animal in H_20 bath in bioeffects studies or med. patient via gel-coupling to skin for diagnostic imaging. In FSMSS [top, p.1], tiny object osc. in viscous liquid at 10^4-10^5Hz dynamically stresses surf. of nearby solid-like object whereby SSMSS acts [**G_{23}**; top, p.1; p.9]. In EIP [p.8], impulsive mech. forces from Mason-horn tip osc. in dry Hertzian contact on epoxy surface generate plate waves to soften Y [p.9], store/erase int. residual stress [**G_{23}**, **G_{31}**; #10&14, p.6], as observed photoelastically to presage SSMSS idea [p.9].	**G_{22}:** Elastodynamic waves (as acoustic emission) are rad. randomly from point sources inside mech. stressed composite material, as in quenching of Nb_3Sn/Cu-matrix cable in field windings of LTS-magnet per R&D proposal with RW Reed ['77-'81] to DOE, plus proof testing of pressure vessels per look at Picatinny Arsenal RFP.	**G_{23}:** Trapped bubble in H_2O cavitates, re-rad. if exposed to pump sound beam; surf. osc. Doppler-shifts probe-beam freq. [ER ex.1 (with WLN), *FP*]. FSMSS sets up dynamic tractions on erythrocyte membrane surf., re-rad. sound into cell interior where SSMSS acts. Shock waves rad. in epoxy if osc. indenter tip softens Y, then goes supersonic [**G_{21}**; SSMSS, Y, p.9].
***ROW 3* Electro-magnetic** *(incl. heat + magnetostatic & electrostatic cases)*	**G_{31}:** Furnace melts Zn/Cu powder into brass ingots [HS sci.-fair proj. ex. (unmentioned), p.1]. Lin. polarized CW MMW-beam passes thru ceramic disc window in MFE design to heat mag. confined fusion plasma by ECRH [#10, p.4 + ER ex.3, pp.16-17, *FP*]. Al_2O_3 green body sinters in microwave oven. Free-space circularly-pol. light beam passes thru strain-birefringent plastic plate stressed by static & dynamic surface forces [**G_{21}**]. Flat EMAT coil sets up magnetostatic fields [#3, p.4].	**G_{32}:** Glycerin reacts with $KMnO_4$ to start **G_{33}** ['54-'60, p.1]. NMR: In DC/RF mag. fields, photons radiate in spectral transitions between nucl. spin states; nucl. Zeeman energy shifts as sample moves per non-relativistic approx. [#12, p.6 + ex.4, pp.18-32, *FP*].	**G_{33}:** Zn+S→ZnS(g) + heat (**G_{32}**, top); molecular beam ejects from rocket motor [**G_{11}** ex; '54-'60, p1]. EMAT field on metal surf. sets up Lorentz forces in nuclei lattice to rad. SAWs on boundary [ER ex.2, p.15, *FP*]; see papers + bk ch. In '14, HMF proposed full book on generalized EMATs [RB**T**, p.10].

Table Notes: Radiation comprises fields of continuous or discrete sources outside, on, or inside a *closed external boundary* ('surface') of test or instrumental material. Fields are static, harmonic (=CW), pulsed or composite (viz., static + dynamic), and can be calculated as multipole expansions of scalar or vector potentials arising at observation points as sums or integrals of source distributions of 0 & higher-order moments. Pulsed fields can be narrowband ($\Delta f/f_c<<1$) or broadband ($\Delta f/f_c\sim½$) with bandwidth $\Delta f\geq 0$ & pulse center frequency f_c. Radiation can be symmetric (e.g., spherical) or beamlike in media like crystal or polycrystal; elastic or viscoelastic, solid or fluid & monolithic or composite. For Cols. 1 & 3, *primary* external sources of wave or particle fluxes act on ext. boundaries as surface tractions set up by transmitter transducers or in thin ion-stopping layer, or propagate within sample with internal interfaces (ex: fast neutrons in nucl. fission reactor core irrad. ceramic polycrystal with grain boundaries). Attenuation of scattered or absorbed fluxes is meas. by detectors & modeled by Beer-Lambert law for exponential decay based on imaginary part of complex propagation constant $k=k'+jk''$ ($j\equiv\sqrt{[-1]}$). For Col. 3, rad. travels as wave or particle flux from *primary* ext. source to **∴** excite *secondary* int. source, amplifying or generating rad. of same or other type as by resonant scattering or mode or energy conversion. With ext. rad. (Cols. 1, 3), *primary* source is turned on or off to see switching effects. Int. source (Cols. 2, 3) may be induced to radiate *randomly* & locally if ext. static field is 'on.' *Exs:* Local *primary* acoustic emission from mech. point sources in composite mat'l when static stress applied (**G_{22}**); stimulated emission/absorption of photons in spectral transitions at Larmor freq. f_L for 2-state I=½ nucl. spin system, with ensemble population diff. expressed in longitudinal macroscopic magnetization $\mathbf{M_o}$, precessing about axis of ext. constant magnetostatic field $\mathbf{B_o}$, tipped to **M** rotating at $2\pi f_L$ radians/s in transverse plane by RF field $\mathbf{B_1}$ ($|\mathbf{B_1}|\ll|\mathbf{B_o}|$) from FID current pulse sequence in saddle-coil around sample then used to detect **M**'s rotation via Faraday's law (**G_{32}**). Also, int. source may rad. *globally* if sample temp. rises, as in sintering or exothermic reaction or radionuclide decays involving *primary* or *secondary* point sources (**G_{12}** for K.E. of α-recoil knock-on atoms). Rad. types *change form* like bulk elastodynamic waves absorbed as heat & surface electromagnetic field creating such waves by Lorentz forces, plus *relate*, as EM rad. from energy transitions in ^{1}H NMR, or 3rd sound incl. both acoustic & temp. waves in adsorbed superfluid ^{4}He thin films. Rad. fields can travel as waves, or particles with group velocity v, de Broglie wavelength λ, Planck frequency f, phase velocity $f\lambda=c^2/v$ (c, speed of light) – with $\Delta f=0$ for CW & f=0 for static (DC) cases. Thermodynamic systems with rad. are *open*; free energy then has Gibbs form with no. of particles of given type unconserved. To *probe* material properties, low *signal* levels of rad. are used; to *change* them, hi-*power* levels are. Microscopic changes in samples incl. ionization & displacement damage *during* irrad.; some *post-irrad.* damage can remain. Related μ-scopic defects incl. point, cluster, dislocation, nano-void in crystal & weak chem.-bond break in crosslinked molecular network; macroscopic defects incl. crack, void, local property gradient. Corres. effects, many turned on at threshold values of wave/particle fluxes: Heating; glass-rubber, metamict or state transition activation; swelling; residual stress; global property change. *Ex:* Y [p.9] softens nonthermally if solid is irrad. by hi-intensity elastodynamic ultrasound. All affect local mat'l processing, stoichiometry, structure & performance properties with relationships at nano- to macro-size scales having impact on designing rad.-stable mat'ls, dev. new image-contrast mechanisms & discovering cause-effect & dose-defect laws to assess rad. safety. HMF's res. ∴ scopes out GREST as useful new interdisciplinary field, e.g., framing new MUBEM proposal, Solid-State Mech. Shear Stress (SSMSS) [**G_{21}**, **G_{23}** *supra*; p.9; '10-'14, p.2; #14, p.6] & adding formal ER method to investigate it [*FP**, pp.1-3 incl. Table I as precursor to *Table* here].

* Most acronyms/abbreviations & some symbols in CV (e.g., **F** or Y) listed/defined on pp.8-9; G_{ij} defined on p.7 in *Table* for "GREST" concept.

ACRONYMS & ABBREVIATIONS with ANNOTATED DEFINITIONS (SOME CROSS-REFERENCED)

AAAS	*Am. Assoc. for Adv. of Sci.* HMF's bio: **membercentral.aaas.org/blogs/member-spotlight/5-things-about-me-physicist-hal-frost**.
ACS	American Chemical Society (**www.acs.org**; a professional non-profit organization). HMF is former member.
ADA or ADAAA	(US) Americans with Disabilities Act (1990) or ADA Amendments Act (2008). Info ex: **www.ada.gov/pubs/ada.htm**.
AFB; AFCRL; AFML	Air Force Base; Air Force Cambridge Research Labs (Hanscom AFB, MA); Air Force Materials Lab. (Wright-Patterson AFB, OH).
AFSC	Air Force Systems Command, which funded HMF's NRC postdoc in 1974-1975 at (former) AFCRL [1974-1975 blocks, pp.1, 2 & 3].
AIP	Am. Institute of Physics (**www.aip.org**). APS & ASA are member societies. Search **http://scitation.aip.org** for HMF paper abstracts.
AIUM	American Institute of Ultrasound in Medicine (**www.aium.org**, a professional non-profit organization). HMF is former member.
AMTED	Army Missile Test & Evaluation Directorate, WSMR, NM, with 800 personnel incl. HMF for 2½ yr as USAR officer under Deputy Director COL F.E. Carpenter [p.10] who saw HMF's technical value. Part of Test & Evaluation Command system in U.S. Army.
APS	American Physical Society (in AIP). HMF has kept up contact via Dr. Paul H. Carr ['74-'75 block, p.3] in New England Section.
ARF	Acoustic radiation force (nonlinear ultrasonic effect), constant in time (DC) or nearly so (low-freq. AC compared to carrier freq.).
ARL	Applied Research Laboratory, at The Pennsylvania State University(**www.arl.psu.edu**), funded under blanket NSSC contract.
ASA	Acoustical Society of America (prof. non-profit organization in AIP) to which HMF once belonged as when a UVM graduate student.
ASNT; ASTM	American Society for NDT; American Society for Testing and Materials. In 2001, ASTM became ASTM International.
BRH; CDRH	Bureau of Radiological Health, former bureau in the FDA, U.S. DHEW, Rockville, MD. Today's version is: Center for Devices & Radiological Health (info via **http://www.fda.gov/MedicalDevices/default.htm**), part of the FDA in now-named (U.S.) DHHS.
CMC	critical micelle conc. of long-chain acids in aq. solution titrated as pH/DC-electr.-conductivity plots [2nd '60-'64, p.1; '62-'62, p.2].
CRREL	Cold Regions Res & Eng Lab, Hanover, NH (via **www.erdc.usace.army.mil/Locations.aspx**); HMF had summer job [2nd '60-'64, p.1].
CST Div	Chemistry Science & Technology Division at LANL, successor of original Chemistry Division there. HMF worked in both.
D&I	Diversity & Inclusion; spectrum includes disability. See **www.opm.gov/policy-data-oversight/diversity-and-inclusion** for federal workforce perspective, plus **www.nsf.gov/od/odi/StrategicPlan.pdf** for NSF strategic plan with a STEM perspective.
DARPA	Defense Advanced Research Projects Agency, which funded some of HMF's res. at LANL on microwave sintering of ceramics.
DHEW; DHHS	Department of Health, Education and Welfare; preceded Department of Health and Human Services (U.S.).
DMS	Dartmouth Medical School, a part of Dartmouth College, Hanover, NH; now Geisel School of Medicine.
DoD & DOE	Dep't of Defense (**www.defense.gov**) & Dep't of Energy (**www.energy.gov**). These provided most of HMF's research project funding.
EAP	Employee Assistance Program at LANL (field office, TA-53). Helped HMF manage disability & stay at work in 1992 but not in 1999.
ECRH	electron cyclotron resonance (secondary) heating, created by powerful MMW beams in MFE or other type of plasma.
EIP	*Elastodynamic Indentation/Penetrometry* or *indenter/penetrator*; contact mechanics topic central to solid mechanics. Ex: Mason-horn wedge-shaped tip osc. with stroke $2u_o$ as line source in contact with viscoelastic solid via force $\mathbf{F}=\mathbf{F_d}+\mathbf{F_s}$ $\perp$ to surf., indents [#2, p.6] or penetrates [2nd #1, p.5] it, via $\mathbf{F_d}$ as AC (dipole) & $\langle\mathbf{F_d}\rangle$ & $\mathbf{F_s}$ as DC loads pressed in creep by $\mathbf{F_s}$ $\perp$ edge of thin plate, giving in-plane radial stress $\sigma_{rr}=(\sigma_{rr})_d+(\sigma_{rr})_s\propto|\mathbf{F}|\cos\Theta/r$. Unloading by $\langle\mathbf{F_d}\rangle\rightarrow\mathbf{0}$, *then* $\mathbf{F_s}\rightarrow\mathbf{0}$ leaves residual stress; $\mathbf{F_s}\rightarrow\mathbf{0}$ *then* $\langle\mathbf{F_d}\rangle\rightarrow\mathbf{0}$ anneals it out.
EM *(2 senses)*	*Electromagnetic* incl. electrostatic/magnetostatic. Or, *Environmental Management* office/program of DOE.
EMAT	Electromagnetic-Acoustic Transducer for NDT of metals & alloys, as by Lorentz forces [exs: '74-'75, p.1; '77-'81, pp.2-3; #3, p.5].
EMBS	Engineering in Medicine and Biology Society (IEEE; **www.embs.org**; prof. non-profit organization). HMF once was member.
EPRI	Electric Power Research Institute, Palo Alto, CA (**www.epri.com**). [*Vide* 1981-1983 blocks, pp.2-3 **+** # 5, p.5].
ER *(2 senses)*	*Energy Research* office/program of DOE. **Or**, *Exploratory Research*, whose formal methodology HMF dev. as described in *FP* * as "Double Hypothesis Algorithm" & "Primary Method" [pp.1-3] and exemplified via 5 of his R&D projects [pp.14-38]. By retrospective analysis of project examples per formats given [p.13], he found this way formed basis of his intuition since 1970's for doing ER.
ESA Div	Engineering Sciences & Applications Division at LANL; formerly, WX Division. HMF worked as Staff Member in both Divisions.
ext. *(2 senses)*	*extensional* (elastic wave, as in wire with phase velocity $\sqrt{[Y/\rho]}$; ρ = mass density) **or** *external; extramural*.
F, $\mathbf{F_d}$, or $\mathbf{F_s}$	Instantaneous dynamic (AC) or static (DC) vector force $\mathbf{F_d}$ or $\mathbf{F_s}$ on localized surface of solid sample pushed by $\mathbf{F_s}$ to contact tip of Mason horn osc. as mech. dipole. In EIP, $\mathbf{F_s}$ is reaction force; analogous to ARF. Total force $\langle\mathbf{F}\rangle=\langle\mathbf{F_d}\rangle+\mathbf{F_s}$; $\langle\ \rangle$ = ultrasonic time ave.
FDA	Food and Drug Administration (**www.fda.gov**) where HMF once worked; agency in former U.S. DHEW but now in present U.S. DHHS.
FP *(2 senses)*	*Frosty's Physics, LLC* [consulting,'10-'14 block, p.2] **or** *business brief titled FP* (HMF; 36pp.; 2010; prospectus, CV, & ER ex's).
FRM	Fusion Reactor Materials. Program's *DOE/ER-03013 Semiannual Progress Reports* are archived full-text at: **web.ornl.gov/sci/physical_sciences_directorate/mst/fusionreactor/semiannual.shtml**. HMF's *contributions* go back to 1st *Report* (*4* in 1986).
GREST	Generalized Radiation Effects Science & Technology. Interdisciplinary research field for ion, nuclear, mechanical & electromagnetic rad. effects, with underlying ER methods dev. by HMF in '10 per *FP supra*. 9 rad.-effect types G_{ij} (i=1,2,3; j=1,2,3) [*Table*/Notes, p.7].
HTS, HTSC	high-temperature superconductivity, high-temperature superconductor ['87-'90 & '89-'90, p.3]. (*Low-temp.* superconductor: $\mathbf{G_{22}}$, p.7).
ICFRM-4	International Conference on Fusion Reactor Materials, Kyoto, Japan, 12/89 (HMF attended, gave talk, co-chaired session).
int. *(2 senses)*	*international*. **Or**, *internal*.
ISMNI	International Society of Musculoskeletal & Neuronal Interactions (**www.ismni.org**; base in Greece). HMF is an honorary member.
ISMRM	International Society for Magnetic Resonance in Medicine. HMF is a former member.
ISRD	Institutional Supporting R & D, former internally administered R&D program at LANL, as funded by DOE. Precursor to LDRD.
ITER	International Thermonuclear Engineering Reactor; expt'l tokamak nuclear fusion reactor under construction (**www.iter.org**).
LAMPF	Los Alamos Meson Physics Facility, now called Los Alamos Neutron Science Center (LANSCE), located at TA-53, LANL.
LANL	Los Alamos Nat'l Laboratory, Los Alamos, NM (**www.lanl.gov**). HMF permanent Staff Member (SM) '84-'95, term SM '98-'01.
LDRD	Laboratory Directed Research and Development; current R&D program internally administered at LANL but funded by DOE.
MCA	multichannel analyzer(s), as used by HMF in nuclear physics lab in graduate school at UVM and then in RANT (*infra*) at LANL.
MFE	Magnetic Fusion Energy, overarching concept driving designs for ITER (*supra*), latest under construction in Cadarache, France.
MMC	metal-matrix composite like: Al/graphite, with CVD-coating of graphite-fiber bundle for wetting/bonding when pulled thru Al melt.
MMW(s)	Millimeter wave(s). Generated by use of IMPATT diodes in HMF's research labs at LANL. In-waveguide & free-space modes.
MPL	Microwave Physics Lab., AFCRL. By cash awards to HMF, Director C. J. Sletten recognized his inventions [1974-1975 line, p.2].

* Most acronyms/abbreviations & some symbols in CV (e.g., **F** or Y) listed/defined on pp.8-9; G_{ij} defined on p.7 in *Table* for "GREST" concept.

MRFM or MRI	Magnetic resonance force microscopy or magnetic resonance imaging; based on NMR. HMF's related technical reports: # 9,12; p.6.
MS&E	materials science and engineering. A discipline in which HMF did ER, as with Frank W. Clinard, Jr. [FW**C**, p.10] in MST-Div at LANL.
MST Div (or DO)	Materials Science & Technology Division (or Div. Office), LANL (**www.lanl.gov/mst**). HMF was in 2 groups, MST-5, then MST-4.
MTTS	Microwave Theory and Techniques Society (of IEEE; **www.mtt.org**); HMF was member while permanent Staff Member at LANL.
MUBEM	Medical Ultrasound Bio-Effect(s) Mechanism. HMF developed model for new one, solid-state mechanical shear stress (SSMSS).
NAE; NAP; NAS	Nat'l Academy of Eng. (**www.nae.edu**); Nat'l Academies Press (**www.nap.edu**); Nat'l Academy of Sciences (**www.nasonline.org**).
NBS	National Bureau of Standards (now NIST). Contact since 1976: Dr. Gerry Blessing (Branch Chief, Ultrasonics Group Gaithersburg).
NDA	Nondestructive Assay of TRU nuclear waste, by active neutron interrogation or by passive neutron counting. See RANT.
NDE/T	nondestructive evaluation/testing, in which HMF held an effective ASNT level-III certification of expertise, as with EMATs.
NIH; NIST	Nat'l Institutes of Health; Nat'l Institute of Standards & Technology (once, NBS), with campuses in Gaithersburg, MD & Boulder, CO.
NMR; NQR	nuclear magnetic resonance; nuclear quadrupole resonance. NMR spectroscopy uses EMAT-like technology ["Contributions…," p.6].
NPSS	Nuclear and Plasma Sciences Society (of IEEE), of which HMF was member [**G$_{12}$**, *Table*, p.7 + FW**C**, p.10].
NRC	National Research Council (part of U.S. National Academies). HMF was a 1974-1975 NRC post-doc at AFCRL *supra*.
NSSC	Naval Sea Systems Command, also called NAVSEA (**www.navsea.navy.mil/default.aspx**). Funded HMF's ER at Penn State.
NSWC	Naval Surface Weapons Center (Dahlgren, VA & White Oak, MD). Contract monitor for HMF's NDT research project at Penn State.
OFE	Office of Fusion Energy, in Office of Energy Res./DOE (today at **science.energy.gov/fes**); funded HMF's LANL research with FW**C**..
OPM	Office of Personnel Mgmt (**www.opm.gov**). HMF shared better business case for incl. persons with disabilities in STEM D&I [top, p.1].
Penn State	Pennsylvania State Univ. (**www.psu.edu**). In ARL 1977-1981 on State College campus, HMF served on Acoustics Program faculty.
PI, PM, or PO	Principal Investigator (of proposed/funded project); proj./program manager; Program Office. HMF was PI at: Penn State; LANL.
RANT	Radioassay & Nondestructive Testing Facility; a LANL nuclear facility where HMF worked to support NDA & WIPP programs.
SSMSS	Solid-State Mech. Shear Stress. New MUBEM model proposed by HMF in 2010's from EIP theses with $\langle \mathbf{F_d} \rangle > \mathbf{0}$, $\mathbf{F_s} > \mathbf{0}$ [2nd #1, p.5; #1, p.6] & later [#2, p.5; *FP*, p.8; #10,14; p.6]. ***Literature context:*** **SSMSS** parallel to Fluid-State Mech. Shear Stress (**FSMSS**) MUBEM dev. by J.A.R. [top, p1; JA**R**, p.10], couples to **SSMSS** [cells **G$_{21}$** & **G$_{23}$**, *Table*, p.7] per P.A. Lewin & L. Bjørnø, "Acoustically induced shear stresses in the vicinity of microbubbles in tissue," *JASA* **71**(3): 726-734 (1982). ***Ansatz****: Shear* elastodynamic rad. of small, uniaxial stress σ_{rr} in source far field obeys *linear* wave eq. (WE; with const. coefficients, $\Box\sigma_{rr}=0$) in creep-loaded biol. tissue 1st taken as viscoelastic (VE) plate obeying Hooke's law $\sigma_{rr}=Y\epsilon_{rr}$ (radial strain ϵ_{rr}) & distortional-wave speed $\sqrt{[\mu/\rho]}$ or $\sqrt{[Y/\rho]}$ (shear & Young's modulus μ & Y; mass density ρ), in polar coordinate frame with axes // principal stress axes, setting up tractions on surfaces bounding solid parts **+** force densities inside from int. stress gradients deforming part shapes via off-diagonal part of strain tensor $\epsilon_{i\neq j}$ based on pure/simple shear forms of particle displacements u_i. Ext. in-plane shear stress (& strain) occurs on planes at ±45º to principal stress (& strain) axes. ***Next:*** Nonlin. constitutive eq. $\sigma_{rr} = Y(\epsilon_{rr})\,\epsilon_{rr}$ [with $Y(\epsilon_{rr}) \propto \epsilon_{rr}+O((\epsilon_{rr})^2)$] models Rayleigh hysteresis for irreversible deformation **+** ultrasonic softening of $Y=Y(\epsilon_{rr})$ ($=3\mu(\epsilon_{rr})$ if Poisson ratio v=½), as by solid order/disorder phase transition on planes aligned with max. shear planes, to yield nonlin. *variable*-coefficient WE in ϵ_{rr} transformed into eq. for forced harmonic osc. solvable for dispersive propagation const. ***Then:*** WE for ARF-forced shear motion in tissue with creep/recovery incl. physical, geometric, & structural effects like supersonic shock front yielding traveling shear waves if $\partial u_r/\partial t > \sqrt{[\mu/\rho]}$ & $\mu \sim 10^2 Pa << K = (2/3)\mu + \lambda$; K=bulk modulus with 2nd Lamé parameter λ>>μ. *Ex:* Khokhlov-Zabolotskaya-Kuznetsov (KZK) eq. in σ_{rr} with hereditary integral for dissipation **+** surge term $\propto$ *3rd* time derivative of stress (*ultrasonic* surge high). **∴** solid part not rigid (size L<<λ) but deforms (L≥λ/2) & fails. ***Also:*** (1) Mat'l anisotropy, (2) $|\langle work \rangle| > 0$ for periodic impacts in forced localized motion of *VE* solid; (3) possible nonthermal compressive or shear residual strain if $\langle \mathbf{F_d} \rangle \rightarrow \mathbf{0}$, *then* $\mathbf{F_s} \rightarrow \mathbf{0}$ [EIP, p.8]. In (3), if μ<<K, unit shear stress causes |shear strain|>>|compressive strain| from unit compressive stress, **∴** more damage on preferred planes in homogeneous mat'l by *shear* than compressive stress, **∴** more in inhomogeneous soft tissue where max. applied shear stress planes coincide with easy shear yield/failure planes. (In **FSMSS** MUBEM [top, p.1], *endogenous* effects with max. resolved shear stress from compressive stress vanish, as principal stress differences in viscous fluid are 0.) ***SSMSS impacts:*** *Principle of equivalence* of $\mathbf{F_s}$ in EIP to examiner-applied force to hold ultrasound transducer against organ for intraoperative imaging **+** ARF in ultrasonic push/track imaging (transducer pressed on *body* surface); *photoelastic* phantom like gelatin gel as elastography/exposimetry test-bed for creep or shear-wave ARF; extension of linear-acoustic math. tissue models to nonlin.-elastodynamic; zebrafish animal model use incl. fertilized embryo to investigate predicted *in vivo* **SSMSS** bioeffect of shear-wave supersonic condition $\partial u_i/\partial t > \sqrt{[\mu/\rho]}$ in human fetus with low μ at high H_20 content (95% at G.A.=1/5 term); corres. impacts on mech. index (MI).
TCE	trichloroethylene, an environmental contaminant as a dense non-aqueous phase liquid in vadose zone of soils. [See JJ**C**, p.10].
TRU	transuranic. Radionuclides as of Pu and Am were assayed in TRU nuclear waste at LANL, as by HMF in certification training.
UC; UCRP	University of California (system); UC Retirement Program based in UC offices in Oakland, CA, within which HMF is annuitant.
UFFCS	Ultrasonics, Ferroelectrics & Frequency Control Soc. (IEEE; **www.ieee-uffc.org**/). Colleague G.V. Blessing was Pres., 2004-2005.
USAF; USAFI	U.S. Air Force; U.S. Armed Forces Institute headquartered in Madison, WI but with educational facility at WSMR (1940's-1970's).
USAR	U.S. Army Reserve. HMF commissioned 06/64 as USAR 2nd Lt. via UVM ROTC program; then was on active duty 11/64-12/67.
UVM	(The) University of Vermont, Burlington, VT (**www.uvm.edu**) where HMF earned 3 physics degrees & held 2 res. faculty posts. See p.10 for 4 UVM faculty vital to HMF's growth as physicist. Alumni bio: **www.uvm.edu/~physics/?Page=alumni/alumni_Frost.html**.
WIPP; WSMR	Waste Isolation Pilot Project, Carlsbad, NM (DOE) [RANT *supra*; '98-'99, p.3]; White Sands Missile Range, NM (DoD) [AMTED *supra*].
Y *(2 senses)*	*yttrium*. **Or** *Young's modulus* [**SSMSS**; '70-'74, p.1; #1,10,14; p.6]. In context of EIP: Mason-horn tip osc. ⊥ edge surf. of thin isotropic homogeneous strain-birefringent viscoelastic (VE) plate exerts total ultrasonic time-ave. line force $\langle |\mathbf{F}| \rangle \propto u_o$ for isothermal intermittent contact conditions, ∴ uniaxial radial creep stress $\langle \sigma_{rr} \rangle$ & strain $\langle \varepsilon_{rr}(t) \rangle = \langle \sigma_{rr}/Y(t) \rangle \cong \langle \sigma_{rr} \rangle / Y(t)$. Via $\mathbf{F_d}$, elastodynamic S_o-Lamb waves rad. at phase velocity $\sqrt{(Y/[\rho(1-v^2)])}$ for mass density ρ, Poisson ratio v, shear modulus μ & $Y=2\mu(1+v)$. ($\sqrt{[Y/\rho]}$= ext. wave speed in wire; $\sqrt{[\mu/\rho]}$ = bulk shear-wave speed.) $Y(t)/Y_o = [J(t)/J_o]^{-1}$ via creep compliance $J(t) \equiv [2\mu(t)]^{-1}$ meas. photoelastically in fixed, Eulerian coord. frame with $d\langle \mathbf{F} \rangle / dt = \mathbf{0}$ & stress-relaxation Young's modulus Y(t) based on loci of $\langle d\varepsilon_{rr}/dt \rangle = 0$ in moving, Lagrangian-like frame. If v=½ (incompressibility), $Y_o J_o = Y_\infty J_\infty = 3/2$ for initial & final values ($\partial J_o/\partial\sigma_{rr} = \partial Y_o/\partial\sigma_{rr} = 0$ in $0 \leq \langle |\sigma_{rr}| \rangle < \langle |\sigma_{rr}|_o \rangle_T$]; like eqns for $Y_\infty \equiv Y(t \rightarrow \infty)$ and $J_\infty \equiv J(t \rightarrow \infty)$). Above threshold stresses $\langle |\sigma_{rr}|_o \rangle_T$ & $\langle |\sigma_{rr}|_\infty \rangle_T$, Y_o & Y_∞ soften & J_o & J_∞ rise, causing nonlin. hysteresis in stress/strain curve over 1 load/unload cycle (on VE retardation/relaxation time scale) enclosing area $\langle \oint \sigma_{rr} d\varepsilon_{rr} \rangle = \int \langle E(t) \rangle dV = \langle W(t) \rangle$, the ave. work in sample vol. to damage material irreversibly. Below thresholds, $\langle \partial W/\partial V \rangle$ = *recoverable* strain energy density $\langle E(t) \rangle \cong J(t) \langle [\sigma_{rr}]^2 \rangle / 3$].

* Most acronyms/abbreviations & some symbols in CV (e.g., **F** or Y) listed/defined on pp.8-9; G_{ij} defined on p.7 in *Table* for "GREST" concept.

TEACHERS, COLLEAGUES, FRIENDS & OTHERS CONTRIBUTING to HMF's PHYSICS CAREER (ex's)

Notes: The 21 names listed here represent & honor *all* those who by altruism helped HMF become research physicist, or sustain scientific research career as after work layoffs or 1st workplace onset in late '89 of major disability [*Per. II*, *Disability Disclosure*, p.1]. Their aid gave HMF early confidence/boldness as physicist & chemist, restoring such traits in recovery from recurrent layoffs & depression. ∴ even in retirement since '08 HMF has had independent prof. life & tech./thematic continuity to his 1950s STEM beginnings, to now teach by integrating knowledge as in GREST* concept, do educational outreach to help STEM students [N**M** *infra*] & advocate social justice for persons in STEM fields with disabilities – as well as do ER like dev. & propose new MUBEM, SSMSS.* So p.10 caps CV with goal of not now getting job but stating case that HMF's >25yr history of workplace mental disability onsets **+** associated layoffs, recoveries & returns to work **+** resulting discrimination by employers & employees, constituted an Ironman runner's test of courage of constant falls, then just crawling, but each time pulled back to his feet by a precious few on sidelines for finally crossing the finish line.

Best, Charles M.	**(1941-2014)** As NAE President in 10/11, invited HMF via Membership Office to draft memorial tribute for WL**N** *infra*, as published in 2012 [#8, p.5].
Bethe, Hans A. (HAB)	**(1906-2005)** Physics Prof., Cornell Univ. **+** sole winner of 1967 Nobel Prize in Physics for his theory of stellar nucleosynthesis. During a consulting visit to LANL, he met with HMF on 08/19/93 to advise him on proposed use of γ rays in photoelastic analogue for analyzing stress in opaque solids like steel and Pu; HAB suggested harmonic oscillator model for γ-ray refractive index ['93-'95 block, p.3 **+** cell G_{13} in Table, p.7 **+** WM**M** block *infra*].
Blessing, Gerald V. (GVB; Dr.)	Ultrasonics Gp Mgr at NIST/Gaithersburg ('91-'00) **+** UFFCS Pres. ('04-'05) **+** UFFCS '06 Distinguished Service Awardee **+** Pres. of Frederick (MD) Chap. of Nat'l Alliance on Mental Illness ('12-'14). HMF at BRH c.'76 met GVB at NBS. In '15 GVB led HMF to res. literature on mental illness stigma.
Carpenter, Frank E. (FEC; Colonel, U.S. Army)	**(1915-1992)** Deputy Director of AMTED [p.8]. (In '41, FEC entered Army as artillery officer in SW Pacific.) As HMF's military supervisor knowing his depression history [lines 1-2 of *Disability Disclosure*, p.1], FEC still allowed HMF to keep DoD Secret security clearance & so continue to work 'behind the fence' as in Microbiology Lab ['66-'66 block, p.1] & QA Office ['66-'67 block, p.2]. Latter led to Army Commendation Medal award just before HMF honorably discharged in '67. Award added confidence to HMF's self-discipline from 3yr active duty, both needed for UVM grad. school [3 blocks, p.1].
Clinard, Frank W. Jr. (FWC; Dr.)	Radiation Effects Sec Ldr, MST-5, then MST-4 (new gp. formed 11/87), LANL. As MFE proj. PI, hired HMF 08/84 to fill vacant Staff Member position, co-authored with him progress report contributions [e.g., #6, p.5] **+** conf.-proc. & res.-journal papers [# 4, p.5; #10, p.4]. FWC supported HMF's growth & independence as research scientist with global contacts until retiring 05/89, increasing workload of HMF (now PI). Also, see LW**H** *infra*.
Coogan, John J. (JJC; Dr.)	Sec Ldr, CST-18, LANL ['95-'97, p.3]. In FY95 HMF as PI in ESA Div recruited JJC into LDRD Program Dev proposal, "Subsurface Directed Energy Methods for Groundwater Treatment," won $60k from EM PO to do FY96 work **after** LANL laid HMF off in 11/95 in large RIF [per. II, *Disabil. Disclo.*, p.1]. So JJC now PI hired HMF as Comforce worker ['96-'97, p.2] to manage proj. JJC bylined "Project Summary" for successful demo of ultrasound-induced TCE transport (p.259, *LDRD FY96 Progress Report*, LA 13278-PR, LANL, 05/97; **www.osti.gov/scitech/servlets/purl/481913**), confirming unanimous 11/96 recommendation by official grievance hearing panel of 3 peers for LANL Director to reinstate HMF after RIF (recommend. rejected).
Doyle, William T. (WTD)	**(1925-2014)** Physics Prof. at Dartmouth College, Hanover, NH. HMF (in high school) was loaned Na-lamp by WT**D** to use in science-fair project. ['54-'60, p.1]. Also, WTD invited HMF into his lab to see electronic Zeeman effect as splitting of Na-D lines in magnetic field, demonstrating mystery & beauty of physics. His friendliness fueled HMF's wish to learn & do more physics + plant seed that after HMF's '08 retirement from UC germinated into dev. new semi-classical theory on nuclear Zeeman effects in solid-state samples ['05-'11, p.1 **+** '07-'11, p.2 **+** #7,9,12; p.6 **+** $\mathbf{G_{32}}$ in Table, p.7].
Good, Roland H. Jr. (RHG; Prof.)	**(1923-2010)** Physics Dep't Chair, Penn State. RHG helped HMF do res. in univ setting during visit to apply for advertised job in Dep't, introducing him to Dr. John C. Johnson, ARL Director, who in turn created/offered new Research Associate position that HMF accepted in 1977 [1st '77-'81, p.2]. Later at Penn State, RHG encouraged HMF to interact with Physics Dep't, leading to path-breaking research in 3rd sound ['77-'81, pp.2-3 **+** #7, p.4].
Hobbs, Linn W. (LWH)	Prof., MS&E Dep't, MIT. FW**C**'s consultant at LANL. Co-authored HMF's publications on neutron rad. effects [#8, p.4; #6, p.5], endorsed HMF's 12/09 nomination of FW**C** *supra* for prestigious IEEE NPSS Annual Rad. Effects Award in 2010 [ex. for '09-'11 part, 2nd "various" (Service) block, p.2].
Inskeep, Richard G. (RGI)	**(1923-2004)** Associate Prof. of Chemistry, UVM. As result of fact-finding visit to RG**I** at UVM in 12/59, HMF decided to go to UVM rather than Dartmouth College where he had also been accepted. RG**I** gave HMF lab space to do physical chemistry project in his freshman year at UVM [1954-1960, p.1]. (But then, unexpectedly to HMF, RG**I** later left UVM for Univ. of Hawaii, Manoa campus, to become Chair of its Chemistry Dep't.)
Krizan, John E. (JEK)	**(1934-1986)** UVM Physics Prof. One of 7 members on HMF's committee approving his dissertation in 08/74 (as did WP**M** & WL**N**, *infra*), before that helping HMF with discussions on effects of mech. stress on biological systems. Via JEK's graduate-level Statistical Mechanics (SM) courses, HMF developed confidence in understanding detailed theoretical physics calculations including (a) discovery of math. identities as with spherical harmonics missed by authors of peer-reviewed res. journal papers & (b) use of their equations in his own res. in biological physics. *In re* (b): JEK's res. papers published in '73-'75 on quantum SM (QSM) indicated to HMF in 2010's his proposed new MUBEM, SSMSS [p.9] could include QSM of biomolecules.
Maksimova, Nina (NM)	President, Dartmouth (College) Physics Soc., (DPS, **physics.dartmouth.edu/undergraduate/physics-society**; as senior, class of '15): Her leadership inspired HMF's '14 philanthropy to DPS to add disability to its D&I work to attract to STEM careers students on campus & in nearby community.
Mason, Warren P. (WPM)	**(1900-1986)** Prof., School of Eng. & Applied Sci., Columbia Univ. Ext. member on HMF's Ph.D. committee; signed his dissertation [#2, p.6], commending its physics insights. Co-ed. Physical Acoustics book series; O.K.'d HMF's outline for Vol.14 ch. [#3, p.5]. WPM's research showed hi-power elastodynamic rad. lowers Y of metal ($\mathbf{F_s=0}$), led HMF in his EIP res. to see it lower epoxy Y ($\mathbf{F_s>0}$) [$\mathbf{\langle F_d \rangle>0}$ for both; $\mathbf{F_d}$, $\mathbf{F_s}$, p.8 **+** SSMSS & Y, p.9].
Mathieson, W. Matt (WMM)	NDT Team Ldr, WX Div. Hired HMF 12/92 when MST-4 mgr let him go in budget crisis & loss of PI status & R&D proj. support after 2nd LOA for depresssion [Per. II, *Disabil. Disclo*., p.1]. WMM OK'd HMF's wish to not work on nucl. bombs (e.g., aging Pu pits), funded his program dev. on automotive NDT, let him do EM R&D in CST-7, had him submit Record of Invention in 11/93 on new NDT method [case #LAD-93-062] with 41-p. report **+** talk to Intellectual Prop. Rev. Bd., *Revolutionary polarized x-ray testing technology*. When WMM retired, HMF lost mgt support & was put on RIF list [JJ**C**].
McCoy, Daisy C. (DCM)	Prof., Math Dep't, Lyndon State College, Lyndon, VT. HMF audited her number theory course in Spring '05, gave required talk at course's end, on ER in analytic number theory [#4, p.6], ∴ returning to productive research after late '89 major disability onset [3rd LOA, period II, *Disabil. Disclo*., p.1].
Neppiras, Ernest A. (EAN; Dr.)	**(1917-1984)** Of Noltingk-Neppiras eq. fame In acoustic cavitation. Visiting scientist at UVM when HMF there in early '60s & '70s. In late '70s, EAN let HMF use his Bournemouth, England flat to finish writing EMAT book. ch. EAN's Mem. tribute by WL**N** in *J. Acoust. Soc. Am.* **77**: 1273 (1985).
Nyborg, Wesley L. (WLN)	**(1917-2011)** UVM Physics Prof.; NAE member. Advised HMF's physics M.S./Ph.D. theses [top, p.1; 2nd #1, p.5; #2, p.6]. As consultant joined HMF at BRH on MUBEM res. ('76-'77). Personally aided HMF's return to work from major disabil. repeat [3rd LOA, per. II, *Disabil. Disclo*., p.1] as in faculty job ['05-'07, p.2] & coauthoring his (WLN's) invited paper [#6, p.6]. Losing last working res. contact when WLN died, HMF wrote his NAE tribute [#8, p.5].
Rooney, James A. (JAR; Res.Assoc.; Dr.)	**(1943-2005)** Fellow UVM physics grad. student in '68-'70, sharing WLN as thesis advisor on mech. stress effects in biol. systems. JAR earned Ph.D. in '70 with dissertation *Hemolysis with ultrasonically induced stable cavitation*, went on to Univ. of Maine at Orono, then JPL/Cal Tech. JAR's 1970's papers proposing new MUBEM, FSMSS [top, p.1; Ref.13, #2, p.6] aided HMF in 2010's to develop his own MUBEM proposal, SSMSS [top, p.1; p.9].
Shoh, Andrew (AS)	**(1930-2010)** Pioneer employee, Branson Ultrasonics Inc., Danbury, CT. Helped HMF with key suggestion to increase ultrasound power used in his physics Ph.D. research at UVM [#2, p.6]. HMF's condolences are at:: **www.tributes.com/condolences/view_memories/89941135#3836533**.
Stimson, Paul K. (PKS)	Guidance Director & Assistant Principal, Hanover High School, Hanover, NH. PKS boosted HMF's academic confidence by dramatic announcement in class in early '60 he'd made top-10 graduating list **+** securing his acceptance into '64 class at Dartmouth. (HMF went to UVM instead; see RG**I**.)
Thompson, R. Bruce (RBT)	**(1941-2011)** Member of NAE **+** Distinguished Prof. in MS&E & Aerospace Eng. Dep'ts at Iowa State Univ., Ames, IA. HMF as '74-'75 posdoc used RB**T**'s '73 paper in *IEEE Trans. Sonics & Ultrason.* to model SAW EMATs ['74-'75, p.1]. At Penn State, HMF in '79 book chapter on EMATs [#3, p.5] used data sent by RBT. After HMF's 11/'95 layoff from LANL [period II, *Disabil. Disclo.*, p.1 **+** '95-'97, p.3], RBT interviewed him for res. job at Iowa State's Center for NDE. RBT's leadership led HMF to develop *pro bono* 24-p. proposal (05/14/14) for 1st book on whole EMAT field, *Generalized EMATs for the 21st Century: Theory, Computation, Experiment and Application Around the Globe*, with a dedication to RBT to honor his memory. More in HMF's condolences at: **news.engineering.iastate.edu/2011/03/08/leading-figure-in-nondestructive-evaluation-bruce-thompson-dies**.

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