(% i1) values;

(% o1)   []

(% i3) usefastarrays:true; use_fast_arrays:true;

(usefastarrays)   true

(use_ fast_ arrays)   true

DEFINING INFO STRUCTURES AND TABLES [HASH ARRAYS]

(% i4) defstruct(var_info(name,value,latex));

(% o4)   [var_info $(name, value, latex)$]

(% i5) defstruct(fun_info(ftyp,name,fargs,body,latex));

(% o5)   [fun_info $(ftyp, name, fargs, body, latex)$]

(% i6) usefastarrays:true;

(usefastarrays)   true

(% i7) defstruct(var_table(count,vars));

(% o7)   [var_table $(count, vars)$]

(% i8) defstruct(fun_table(count,funs));

(% o8)   [fun_table $(count, funs)$]

MANUAL OPERATIONS USING STRUCTURES AND HASH ARRAYS

(% i9) vinfo_ch01:new(var_info);

(vinfo_ ch01)   var_info $(name, value, latex)$

(%   vinfo_ch01@name:P_p1_s;
i10)

(% o10) P_p1_s

1

(% i11)   vinfo_ch01@value:0.0531;

(% o11)   0.0531

(% i12)   vinfo_ch01@latex:[['math,"P_\\scriptscriptstyle[+1,s]"],['text,"P_[+1,s]"]];

(% o12) $[[math,$

$P_- \{\backslash scriptscriptstyle\{[+1,s]\}\}], [text, P_- \{[+1,s]\}$

$]]$

(% i13)   assoc('math,vinfo_ch01@latex);

(% o13)

$P_- \{\backslash scriptscriptstyle\{[+1,s]\}\}$

(% i14)   assoc('text,vinfo_ch01@latex);

(% o14)

$P_- \{[+1,s]\}$

(% i15)   vch01_ltx:assoc(math,vinfo_ch01@latex);

(vch01_ ltx)

$P_- \{\backslash scriptscriptstyle\{[+1,s]\}\}$

(% i16)   vch01_ltx;

(% o16)

$P_- \{\backslash scriptscriptstyle\{[+1,s]\}\}$

(% i17)   vtab_ch01:new(var_table);

(vtab_ ch01)   var_table $(count, vars)$

(%
i18) vtab_ch01@vars:[vinfo_ch01];

(% o18)

$[var\_info\,(name = P\_p1_s, value = 0.0531, latex = [[math, P\_\{\backslash scriptscriptstyle\{[+1,s]\}\}], [text, P\_\{[+1,s]\}]])]$

(%
i19) vtab_ch01@count:1;

(% o19)   1

(%
i20) finfo_Pv_z:new(fun_info);

$(finfo\_\,Pv\_\,z)$ $fun\_info\,(ftyp, name, fargs, body, latex)$

(%
i21) finfo_Pv_z@ftyp:"FUN";

(% o21)

FUN

(%
i22) finfo_Pv_z@name:P_v;

(% o22) P_v

(%
i23) finfo_Pv_z@fargs:[z];

(% o23) $[z]$

(%
i24) finfo_Pv_z@body:"abs(w_v)*sum(p_m*abs(a_vm(z))^2,m,minf,inf)";

(% o24)

$abs(w\_\,v) \cdot sum(p\_m \cdot abs(a\_vm(z))^2, m, minf, inf)$

(%
i25) finfo_Pv_z@latex:"P_\\nu(z)~=~\\left— \\omega_\\nu \\right—~\\sum_
\\infty^\\infty~p_m~\\left—~a_-\\nu~(z)\\right—^2";

(% o25)

$P_- \backslash nu(z) \sim=\sim \backslash left|\backslash omega_-\backslash nu\backslash right| \sim \backslash sum_-\{-\backslash infty\}\{\backslash infty\} \sim p_-\{m\} \sim \backslash left| \sim a_-\{-\backslash nu\} \sim (z)\backslash r$

ftab_ch01:new(fun_table);

(ftab_ ch01) fun_table $(count, funs)$

ftab_ch01@count:1;

(% o27) 1

ftab_ch01@funs:[finfo_Pv_z];

(% o28) [fun_info($ftyp =$

FUN

, $name = P_v, fargs = [z], body =$

abs(w_ v)·$sum(p\_m \cdot abs(a\_vm(z))$)2$, m, minf, inf), latex =$
$P_- \backslash nu(z) \sim=\sim \backslash left|\backslash omega_-\backslash nu\backslash right| \sim \backslash sum_-\{-\backslash infty\}\{\backslash infty\} \sim p_-\{m\} \sim \backslash left| \sim a_-\{-\backslash nu\} \sim (z)\backslash r$

finfo_Pdz_z:new(fun_info);

(finfo_ Pdz_ z) fun_info $(ftyp, name, fargs, body, latex)$

finfo_Pdz_z@ftyp:"FUN";

(% o30)

FUN

finfo_Pdz_z@name:P_dz;

(% o31) P_{dz}

finfo_Pdz_z@fargs:[z];

(% o32) $[z]$

4

finfo_Pdz_z@body:"diff(sum(q_v*p_m*abs(a_vm(z))^2,m,minf,inf),z)";

(% o33)

$\text{diff}(\text{sum}(q\_ \text{v} \cdot p\_m \cdot abs(a\_vm(z))^2, m, minf, inf), z)$

(%
i34) finfo_Pdz_z@latex:"P_dz(z)~= ~\\left—~\\omega_\\nu~\\right—~\\sum_
\\infty^\\infty~p_m~\\left—~a_-\\nu~(z)\\right—^2";

(% o34)

$P\_\{dz\}(z) \sim = \sim \left| \sim \omega\_\nu \sim \right| \sim \sum\_\{-\infty\}\{\infty\} \sim p\_\{m\} \sim \left| \sim a\_\{-\nu\} \sim$

(%
i36) finfo_S_w0:new(fun_info); finfo_S_w0@name:'finfo_S_w0;

(finfo_ S_ w0) $\text{fun\_info}\,(ftyp, name, fargs, body, latex)$

(% o36) $finfo\_S\_w0$

(%
i37) finfo_S_w0;

(% o37) $\text{fun\_info}\,(ftyp, name = finfo\_S\_w0, fargs, body, latex)$

(%
i38) finfo_S_w0@body:"A* sin(w_0*t+phi)";

(% o38)

$\text{A} \cdot sin(w\_0 \cdot t + phi)$

(%
i39) finfo_S_w0@fargs: [A,w_0,t,phi];

(% o39) $[A, w_0, t, phi]$

(%
i40) finfo_S_w0@ftyp:"SYMBOLIC";

(% o40)

SYMBOLIC

(% finfo_S_w0;
i41)
(% o41)
fun_info $(ftyp = SYMBOLIC, name = finfo\_S\_w0, fargs = [A, w_0, t, phi], body = A \cdot sin(w\_0 \cdot t + phi), latex)$

(% finfo_S_w0@latex: "S(A, \\omega_0, t, \\phi)=A \\cdot sin(\\omega_0 \\cdot
i42) t + \\phi)";

(% o42)

$S(A, \omega\_0, t, \phi) = A\cdot sin(\omega\_0\cdot t + \phi)$

(% arr_funs[finfo_S_w0@name]:finfo_S_w0;
i43)

ARRSTORE: use_ fast_ arrays=true; allocate a new value hash table for $ ARR_ FUNS

(% o43)   fun_info($ftyp =$

SYMBOLIC

$, name = finfo\_S\_w0, fargs = [A, w_0, t, phi], body =$

$A\cdot sin(w\_0 \cdot t + phi), latex =$
$S(A, \omega\_0, t, \phi) = A\cdot sin(\omega\_0\cdot t + \phi))$

(% arr_funs['finfo_S_w0]@latex;
i44)

(% o44)

$S(A, \omega\_0, t, \phi) = A\cdot sin(\omega\_0\cdot t + \phi)$

(% tf01@body;
i45)

(% o45) $tf01@body$

(% finfo_S_w0@body;
i46)

(% o46)

A$\cdot sin(w\_0 \cdot t + phi)$

(%   fp:[['ftyp,   "SYMBOLIC"],['name,'Ak_A0_kA_z],['fargs,
i47)   [A_0,k_A,z]],['body,   "(A_0/z)*sin(k_a*z)*exp(-%i*z/4*%pi)"],['latex,
        "\\fracA_0z\\,sin(k_a~z)~e^\\left(\\frac-i~\\pi~z4\\right)"]] ;

(fp) $[[ftyp,$

SYMBOLIC

                    $], [name, Ak\_A0\_kA_z], [fargs, [A_0, k_A, z]], [body,$

$(A\_\ 0/z) \cdot sin(k\_a \cdot z) \cdot exp(-\%i \cdot z/4 \cdot \%pi)], [latex,$
$\backslash frac\{A\_\{0\}\}\{z\}\backslash, sin(k\_a \sim z) \sim \hat{e}\{\backslash left(\backslash frac\{-i \sim \backslash pi \sim z\}\{4\}\backslash right)\}]]$

(%   assoc('latex,fp);
i48)

(% o48)

$\backslash frac\{A\_\{0\}\}\{z\}\backslash, sin(k\_a \sim z) \sim \hat{e}\{\backslash left(\backslash frac\{-i \sim \backslash pi \sim z\}\{4\}\backslash right)\}$

(%   arr_funs['finfo_S_w0]@latex;
i49)

(% o49)

$S(A, \backslash omega\_0, t, \backslash phi) = A\backslash cdot sin(\backslash omega\_0\backslash cdot t + \backslash phi)$

(%   arr_funs['Ak_A0_kAz];
i50)

(% o50)   false

DEFINING FUNCTIONS TO ADD STRUCTURES TO HASH ARRAYS US-
ING FUNCTION NAME AS HASH KEY FOR LOOKUP. WORKS WELL
AND SEEMS FAST ENOUGH FOR TESTING COMPILE ALL CODE TO
LISP ONCE IT WORKS - BETTER PERFORMANCE RESULTS ftyp FIELD
- FOR NOW USE IT FOR NUMERIC OR SYMBOLIC

(%   make_finfo(fl):=new(fun_info("assoc('ftyp, fl),"assoc('name,fl),"assoc('fargs,fl),"assoc('body,fl),"assoc(
i51)   ;
(% o51)
$make\_finfo(fl) := new(fun\_info(ftyp = \neq \{Lispfunction\}('ftyp, fl), name = \neq \{Lispfunction\}('name, fl), fargs$

(%   add_fun(fl):=arr_funs["assoc('name,fl)]:make_finfo(fl);
i52)

(% o52) $add\_fun(fl) := arr\_funs_{\neq\{Lispfunction\}('name, fl)} : make\_finfo(fl)$

ADDING ITEMS WITH add_fun

(%
i53)
add_fun([['ftyp, "SYMBOLIC"] , ['name,'E_r_t_z_t] , ['fargs, [r_t,z,t]] ,
['body, "sum(A_k(A_0,k_A,z)*E_k(r_t)*exp(%i*ω*t-γ_k*z),k,minf,inf)"] , ['la-
tex, "E(r_t,z,t)~=~\\sum_k=-\\infty^ \\inftyA_k(A_0,k_A,z)~E_k(r_t)~e^
\\left(i \\omega t-\\gamma_k z\\right) "]]);

$(\% \ o53)$ $\qquad$ fun_info($ftyp =$

SYMBOLIC
$$, name = E\_r\_t\_z_t, fargs = [r_t, z, t], body =$$

$\text{sum}(A\_ \text{k}(A\_0,k\_A,z)\cdot E\_k(r\_t)\cdot exp(\%i\cdot\omega\cdot t-\gamma\_k\cdot z), k, minf, inf), latex = \text{E}(r\_$
$\text{t,z,t})\sim=\sim \setminus sum\_\{k = -\infty\}\{\infty\}A\_k(A\_0, k\_A, z) \sim E\_k(r\_t) \sim \hat{e}\{\setminus left(i\setminus omegat - \setminus gamma\_kz\setminus righ$

(%
i54)
arr_funs[E_r_t_z_t];

$(\% \ o54)$ $\qquad$ fun_info($ftyp =$

SYMBOLIC
$$, name = E\_r\_t\_z_t, fargs = [r_t, z, t], body =$$

$\text{sum}(A\_ \text{k}(A\_0,k\_A,z)\cdot E\_k(r\_t)\cdot exp(\%i\cdot\omega\cdot t-\gamma\_k\cdot z), k, minf, inf), latex = \text{E}(r\_$
$\text{t,z,t})\sim=\sim \setminus sum\_\{k = -\infty\}\{\infty\}A\_k(A\_0, k\_A, z) \sim E\_k(r\_t) \sim \hat{e}\{\setminus left(i\setminus omegat - \setminus gamma\_kz\setminus righ$

(%
i55)
arr_funs[E_r_t_z_t]@name;

$(\% \ o55)$ $\qquad\qquad E\_r\_t\_z_t$

(%
i56)
arr_funs[E_r_t_z_t]@ftyp;

$(\% \ o56)$

SYMBOLIC

(%
i57)
arr_funs[E_r_t_z_t]@fargs;

$(\% \ o57)$ $\qquad\qquad [r_t, z, t]$

(%
i58)
arr_funs[E_r_t_z_t]@body;

$(\% \ o58)$

8

$sum(A\_\,k(A\_\,0,k\_\,A,z) \cdot E\_k(r\_t) \cdot exp(\%i \cdot \omega \cdot t - \gamma\_k \cdot z), k, minf, inf)$

arr_funs[E_r_t_z_t]@latex;

(% o59)

$E(r\_\,t,z,t) \sim = \sim \backslash sum\_\{k = -\backslash infty\}\{\backslash infty\}A\_k(A\_0, k\_A, z) \sim E\_k(r\_t) \sim \acute{e}\{\backslash left(i\backslash omegat - \backslash gamma\_kz\backslash$

(% i60) add_fun([['ftyp, "SYMBOLIC"] , ['name,'EQ_1242_B] , ['fargs, [z]] , ['body, "abs(w_v)*sum(p_m*abs(a_vm(z))^2,m,minf,inf)"] , ['latex, "P^\\left(\\nu \\right)(z)=p_m \\left—w_v \\right— \\sum_m=- \\infty^\\inftyp_m~\\left—a_m^\\left(\\nu\\right)(z)\\right—^2"]]);

(% o60)   fun_info($ftyp =$

SYMBOLIC

                $, name = EQ\_1242\_B, fargs = [z], body =$

$abs(w\_\,v) \cdot sum(p\_m \cdot abs(a\_vm(z))2, m, minf, inf), latex =$
$P\char94\{\backslash left(\backslash nu\backslash right)\}(z) = p\_m\backslash left|w\_v\backslash right|\backslash sum\_\{m = -\backslash infty\}\{\backslash infty\}p\_m \sim \backslash left|a\_m\char94\{\backslash left(\backslash nu\backslash r$

arr_funs[EQ_1242_B];

(% o61)   fun_info($ftyp =$

SYMBOLIC

                $, name = EQ\_1242\_B, fargs = [z], body =$

$abs(w\_\,v) \cdot sum(p\_m \cdot abs(a\_vm(z))2, m, minf, inf), latex =$
$P\char94\{\backslash left(\backslash nu\backslash right)\}(z) = p\_m\backslash left|w\_v\backslash right|\backslash sum\_\{m = -\backslash infty\}\{\backslash infty\}p\_m \sim \backslash left|a\_m\char94\{\backslash left(\backslash nu\backslash r$

(% i62) arr_funs[EQ_1242_B]@ftyp;

(% o62)

SYMBOLIC

(% i63) arr_funs[EQ_1242_B]@name;

(% o63) EQ_1242_B

(% i64) arr_funs[EQ_1242_B]@fargs;

(% o64) $[z]$

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(% o65)

$abs(w\_ v) \cdot sum(p\_m \cdot abs(a\_vm(z))2, m, minf, inf)$

(% o66)

$P\hat{\ }\{\left(\nu\right)\}(z) = \left|w\_v\right|\sum\_\{m = -\infty\}\{\infty\}p\_m \sim \left|a\_m\hat{\ }\{\left(\nu\right.$

(% o67) $fun\_info(ftyp =$

SYMBOLIC

                , $name = E\_r\_t\_z_t, fargs = [r_t, z, t], body =$

$sum(A\_ k(A\_ 0, k\_ A, z) \cdot E\_k(r\_t) \cdot exp(\%i \cdot \omega \cdot t - \gamma\_k \cdot z), k, minf, inf), latex = E(r\_$
$t, z, t) \sim = \sim \sum\_\{k = -\infty\}\{\infty\}A\_k(A\_0, k\_A, z) \sim E\_k(r\_t) \sim \hat{e}\{\left(i \sim \omega \sim t - \gamma\_k\right.$

(% o68) $fun\_info(ftyp =$

SYMBOLIC

                , $name = H\_r\_t\_z_t, fargs = [r_t, z, t], body =$

$sum(A\_ k(A\_ 0, k\_ A, z) \cdot H\_k(r\_t) \cdot exp(\%i \cdot \omega \cdot t - \gamma\_k \cdot z), k, minf, inf), latex = H(r\_$
$t, z, t) \sim = \sim \sum\_\{k = -\infty\}\{\infty\}A\_k(A\_0, k\_A, z) \sim H\_k(r\_t) \sim \hat{e}\{\left(i \omega \sim t - \gamma\_k z \right.$

(% o69) $fun\_info(ftyp =$

SYMBOLIC

                , $name = EQ\_3217_A, fargs = [I_P, N], body =$

$(1/2) \cdot avg\_t(E.'diff(P,t)), latex =$
$avg\_t \left(I\_P, N\right) = \frac{1}{2} \sim avg\_t\left(E\cdot\frac{\partial{P}}{\partial{t}}\right))$

(% i70) arr_funs[EQ_3217_A]@latex: "avg_t \\left(I_P,N \\right) = \\frac12~avg_t \\left(E \\cdot \\frac\\partialP\\partialt - P \\cdot \\frac\\partialE\\partialt\\,N \\right)";

(% o70)

$avg\_t \left(I\_P, N\right) = \frac{1}{2} \sim avg\_t\left(E\cdot\frac{\partial{P}}{\partial{t}} - P\cdot\frac{\partial{E}}{\partial{t}}\, N\right)$

(% i71) add_fun([['ftyp, "SYMBOLIC"] , ['name,'EQ_3217_B] , ['fargs, [I_P,N]] , ['body, "avg_t(I_P,N)=(1/2)*avg_t(E.'diff(D,t)-D.'diff(E,t),N)"] , ['latex, "avg_t \\left(I_P,N \\right) = \\frac12~avg_t \\left(E \\cdot \\frac\\partialD\\partialt - D \\cdot \\frac\\partialE\\partialt,N \\right)"]]);

(% o71)   fun_info($ftyp =$

SYMBOLIC
$, name = EQ\_3217_B, fargs = [I_P, N], body =$

$avg\_t(I\_P,N)=(1/2)\cdot avg\_t(E.'diff(D,t) - D.'diff(E,t),N), latex =$
$avg\_t \left(I\_P, N\right) = \frac{1}{2} \sim avg\_t\left(E\cdot\frac{\partial{D}}{\partial{t}} - D\cdot\frac{\partial{E}}{\partial{t}}, N\right))$

(% i72) add_fun([['ftyp, "SYMBOLIC"] , ['name,'EQ_3217_C] , ['fargs, [I_P,N]] , ['body, "avg_t(I_P,N)=(1/4)*'realpart('conjugate(E).(%i*ω*D)-'conjugate(D).(%i*ω*E))"] , ['latex, "avg_t \\left(I_P,N \\right) = \\frac14~Re \\left(\\overlineE \\cdot \\left(i \\omega D \\right) - \\overlineD \\cdot \\left(i \\omega E \\right) \\right)"]]);

(% o72)   fun_info($ftyp =$

SYMBOLIC
$, name = EQ\_3217_C, fargs = [I_P, N], body =$

$avg\_t(I\_P,N)=(1/4)\cdot'realpart('conjugate(E).(\%i\cdot\omega\cdot D) -'conjugate(D).(\%i\cdot\omega\cdot E)), latex =$
$avg\_t \left(I\_P, N\right) = \frac{1}{4} \sim Re\left(\overline{E}\cdot\left(i\omega D\right) - \overline{D}\cdot\left(i\omega E\right)\right))$

(% i73) arr_funs[EQ_3217_C@latex]:"P_dz \\left(z \\right) = \\frac \\partial\\partialz \\sum_m=-\\infty^\\inftyq_vp_m\\left—~a_m^\\left(\\nu \\right)(z)\\right—^2";

(% o73)

P_{-} dz $\left(z\right) = \frac{\partial}{\partial{z}}{\sum_{m=-\infty}{\infty}q_{-}vp_{-}m\left| \sim a_{-}m\hat{}\left|$

(% o74)

$$\text{avg}_{-}t \left(I_{-}P, N\right) = \frac{1}{4} \sim Re\left(\overline{E}\cdot\left(i\omega D\right)-\overline{D}\cdot\left(i\omega E\right)\right)$$

(% o75)   fun_info($ftyp =$

SYMBOLIC

$$, name = EQ\_3217_D, fargs = [I_P, N], body =$$

$\text{avg}_{-}t(I_{-}\text{P,N})=(1/4)\cdot'realpart(\%i\cdot'\omega\cdot('conjugate(E).\epsilon\_bar.E+'conjugate(E)\cdot \xi\_bar.H-E.'conjugate(\epsilon\_bar).'conjugate(E)-E.'conjugate(\xi\_bar).'conjugate(H))), latex =$

$$\text{avg}_{-}t \left(I_{-}P, N\right) = \frac{1}{4} \sim Re\left(\overline{E}\cdot\left(i\omega D\right)-\overline{D}\cdot\left(i\omega E\right)\right))$$

(% o76)

$\text{avg}_{-}t \left(I_{-}P, Nright) = \frac{1}{4} \sim Re\left(i\omega E\{\cdot\}\cdot\left(\bar{\epsilon} - \bar{\epsilon}$

(% o77)   fun_info($ftyp =$

SYMBOLIC

$$, name = EQ\_3217_F, fargs = [I_P, N], body =$$

avg$_-$ t(I$_-$ P,N)=(1/2)$\cdot'realpart(\%i \cdot \omega \cdot ('conjugate(\epsilon\_bar).E.'conjugate(E)) +$
$\epsilon\_bar.H.'conjugate(E)), latex =$
avg$_-$t $\left(I\_P, N\right) = \frac{1}{2}Re\big\backslash\{i\omega\left(\bar{\epsilon}\}\{\sim a\} : EE\{\cdot\} + \backslash xi : HE\{\cdot\}$

(% o79)

avg$_-$t $\left(I\_P, N\right) = \frac{1}{4} \sim Re\left(\overline{E}\cdot\left(i\omega D\right)-$
$\overline{D}\cdot\left(i\omega E\right)\right)$

(% o78)

avg$_-$t $\left(I\_P, Nright\right) = \frac{1}{4} \sim Re\left(i\omega E\{\cdot\}\cdot\left(\bar{\epsilon} - \bar{\epsilon}\right.\right.$

(% o80)   false

(% o81)   false