The previous elliptic regularization and the statement involving the equation (13) from [8] permit to prove that the range of the operator $\mathcal{D}^{s+1}|_{\mathfrak{X}_0^{s+1}} = \alpha_g^0$ is closed with a closed complement $\operatorname{Ker} D^{s+2}|_{\operatorname{Im} D^{s+2}|_{\mathfrak{X}_0^{s+3}}}$.

The utilisation of the manifold $\mathcal{M}_0^s$ instead of $\mathcal{M}^s$ in Prop. 6.13 from [3] causes no difficulty in the proof so that this completes the proof of the theorem.

Now, proceeding along the standard lines of the Ebin Slice theorem it is straightforward to show that the action of $\mathcal{D}_0^{s+1}$ on $\mathcal{M}_0^s$ has a slice.

Remarks: 1. The usual consequences of the existence of a slice, such as generically trivial isotropy groups, follow directly.

2. A slice for the action of the conformorphism group $\mathcal{C}$ on $\mathcal{M}$ in the case $\partial M = \varnothing$ is constructed by A. Fischer and J. Marsden in [5]. Now it is not difficult to extend this result to the case where M has boundary.

REFERENCES

1. Agmon S., Douglis A. and Nirenberg L. — *Estimates near the boundary for the solutions of elliptic differential equations satisfying general boundary conditions II*, Commun Pure Appl. Math. 7 (1964), 35—92.
2. Berger M. and Ebin D. — *Some decompositions of the space of symmetric tensors on a Riemannian manifold*, J. Differ. Geom. 3, (1969), 379—392.
3. Ebin D. — *The manifold of Riemannian metrics*. Proc. Symp. Pure Math. Amer. Math., Soc., 15, (1970), 11—44.
4. Ebin D. and Marsden J. — *Groups of diffeomorphisms and the motion of an incompresible fluid*, Ann. Math., 92, (1970), 102—163.
5. Fischer A. E. and Marsden T. — *The manifold of conformally equivalent metrics*, Can. J. Math. 29, (1977), 193—209.
6. Hamilton R. — *Deformation of complex structures on manifolds with boundary II; families of non-coercive boundary value problems*, J. Differ. Geom. 14, (1979), 409—473.
7. Hörmander L. — *Linear Partial Differential Operators*, Springer Verlag, 1963.
8. Kohn T. T. and Nirenberg L. — *Non-coercive boundary value problems*, Commun. Pure Appl. Math., 18, (1965), 443—492.
9. Koiso N. — *A decomposition of the space of Riemannian metrics on a manifold*, Osaka J. Math., 16, (1979), 423—429.
10. Omori H. — *Infinite dimensional Lie transformation groups*, Lectures Notes in Math. 427, Springer Verlag, 1974.
11. Palais R. — *Seminar on the Atiyah-Singer Index Theorem*, Princeton Univ. Press, 1965.
12. Palais R. — *Foundations of Global Non-Linear Analysis*, W.A. Benjamin; Inc. New-York, Amsterdam, 1968.

Received 5.XII.1986

Seminarul Matematic „Al. Myller"
Universitatea „Al. I. Cuza" Iași
6600, Iași, România

Analele științifice ale Universității „Al. I. Cuza" din Iași
Tomul XXXIV, s. I a. Matematică, 1988, f. 1

RULED REAL HYPERSURFACES IN QUATERNIONIC PROJECTIVE SPACE

BY

A. MARTINEZ

1. **Introduction.** Let QP^m be the $4m$-dimensional quaternionic projective space and M a real hypersurface of QP^m. We say that M is a *ruled* real hypersurface if there is a foliation of M by quaternionic hyperplanes QP^{m-1} (see Definition 1). This type of submanifolds has the following property:

(*) All the quaternionic sectional curvatures are constant 4.

In this paper we obtain examples of minimal ruled real hypersurfaces of QP^m and we study the real hypersurfaces of QP^m with constant quaternionic sectional curvatures.

2. **Preliminaries.** Let Q be the algebra of quaternions. In Q^{m+1} we consider the usual symplectic product given by

$$(a, b) = \Sigma_{i=0}^{m} \bar{a}_i b_i \tag{2.1}$$

for any $a(a_0, \ldots, a_m)$, $b(b_0, \ldots, b_m)$ in Q^{m+1}, where by $\bar{a}_i$ we denote the quaternionic conjugate of a_i.

Let $S^{4m+3} = \{q \in Q^{m+1} | g_0(q, q) = 1\}$ be the unit sphere in Q^{m+1}, where $g_0 = \operatorname{Re}(\ ,\ )$ is the usual Euclidean metric of Q^{m+1}. It is known, [2, 4], that the $4m$-dimensional quaternionic projective space can be obtained from S^{4m+3} by identifying q to λq, $\lambda \in Q$, $|\lambda| = 1$. Thus S^{4m+3} is a fibre bundle over QP^m with structural group S^3 and projection π. If $q \in S^{4m+3}$, the horizontal subspace of $T_q S^{4m+3}$ is $T'_q = \{p \in Q^{m+1} | (p, q) = 0\}$ and the vertical subspace is spanned by $j_1 q$, $j_2 q$ and $j_3 q$, where j_1, j_2 and j_3 are the unit quaternions.

We shall consider on QP^m the metric given by

$$g(X, Y) = g_0(X', Y') \tag{2.2}$$

and the connection

$$\bar{\nabla}_X Y = (\pi)_*(D_{X'} Y'). \tag{2.3}$$

for nay $X, Y \in TQP^m$, where $'$ denotes the corresponding horizontal lift and D is the covariant differentiation of S^{4m+3}.

If over QP^m we consider the 3-dimensional vector bundle V of tensors of type (1, 1) with local basis of almost Hermitian structures $\{J_1, J_2, J_3\}$ given by

$$(2.4)\qquad J_k X=(\pi)_*(j_k X'),\quad k=1,2,3,$$

for any $X\in TQP^m$, then QP^m is a quaternion Kaehlerian manifold with constant sectional curvature 4 and so, (see [2]).

$$(2.5)\quad R(X,Y)Z=g(Y,Z)X-g(X,Z)Y+\Sigma_{k=1}^{3}\{g(J_kY,Z)J_kX-g(J_kX,Z)J_kY+$$
$$+2g(X,J_kY)J_kZ\}.$$

$$(2.6)\qquad \nabla_X J_i=-p_j(X)J_k+p_k(X)J_j,\qquad i=1,2,3.$$

for any X, Y, $Z\in TQP^m$, where $\overline{R}$ denotes the Riemannian curvature tensor of $\overline{\nabla}$, (i,j,k) is a cyclic permutation of $(1,2,3)$ and p_j, $j=1,2,3$ are local 1-forms on QP^m.

Let M be a real hypersurface of QP^m and N a unit local normal vector field to M. We shall denote $U_k=-J_kN$, $k=1,2,3$. $\mathbf{D}'=\mathrm{Sp}\{U_1,U_2,U_3\}$ and $\mathbf{D}$ the orthogonal complement of D' in TM. For any vector field $X\in TM$ we can write.

$$(2.7)\qquad J_kX=P_kX+f_k(X)N\qquad k=1,2,3,$$

where P_kX is the tangent component of J_kX and $f_k(X)=g(X,U_k)$, $k=1,2,3$.

Let A be the Weingarten, endomorphism of M. From (2.5), (2.6), (2.7) and the equations of Gauss and Codazzi it follows.

$$(2.8)\quad R(X,Y)Z=g(Y,Z)X-g(X,Z)Y+\Sigma_{k=1}^{3}\{g(P_kY,Z)P_kX-g(P_kX,Z)P_kY+$$
$$+2g(X,P_kY)P_kZ\}+g(AY,Z)AX-g(AX,Z)AY,$$

$$(2.9)\quad (\nabla_XA)Y-(\nabla_YA)X=\Sigma_{k=1}^{3}\{f_k(X)P_kY-f_k(Y)P_kX+2g(X,P_kY)U_k\}.$$

$$(2.10)\qquad \nabla_XU_i=-p_j(X)U_k+p_k(X)U_j+P_iAX,\quad i=1,2,3$$

for any X, Y, $Z\in TM$, where ∇ is the covariant derivative on M induced by $\overline{\nabla}$, R is the curvature tensor of ∇, (i,j,k) is a cyclic permutation of $(1,2,3)$ and $(\nabla_XA)Y=\nabla_XAY-A\nabla_XY$.

Definition 1. *A real hypersurface M of QP^m is called ruled if the distribution $\mathbf{D}$ is integrable. In this case, there is a foliation of M by quaternionic hyperplanes QP^{m-1}.*

From [6], it is easy to see that M is ruled if and only if

$$(2.11)\qquad g(AD,D)=\{0\}.$$

3. Some ruled real hypersurfaces of QP^m. Let $\overline{M}$ be the hypersurface of S^{4m+3} given by:

$$\overline{M}=\{q=(r\cos\varphi q_0,\ r\sin\varphi q_1,\ (1-r^2)^{1/2}q_2,\ \dots,\ (1-r^2)^{1/2}q_m)\in S^{4m+3}\,|\,0\leq\varphi<$$
$$<2\pi,\ 0<r<1,\ |q_0|=|q_1|=1,\ g_0(r\cos\varphi q_0,\ r\sin\varphi q_1j_1)=0\}.$$

It is clear that $\overline{M}$ is invariant under the action of S^3 and so, $\pi(\overline{M})=M$ is a real hypersurface of QP^m.

Proposition. *M is a minimal ruled real hypersurface of QP^m.*

Proof. Let $q=(r\cos\varphi q_0,\ r\sin\varphi q_1,(1-r^2)^{1/2}q_2,\dots,(1-r^2)^{1/2}q_m)\in\overline{M}$ and $X=(x_0,x_1,\dots,x_m)$ be a tangent vector to S^{4m+3} at q, then from the definition of $\overline{M}$,

$$(3.1)\qquad \begin{aligned}&g_0(X,q)=0,\\ &\sin\varphi g_0(x_0,q_1j_1)+\cos\varphi g_0(q_0,x_1j_1)=0.\end{aligned}$$

Thus, from (2.1) and (3.1) it is easy to see that

$$(3.2)\qquad \begin{aligned}&\overline{X}_k=(\cos\varphi j_kq_0,\ \sin\varphi j_kq_1,0,\dots,0) && k=1,2,3,\\ &\overline{X}_{3+k}=(-\sin\varphi j_kq_1j_1,\ \cos\varphi j_kq_0j_1,0,\dots,0) && k=1,2,3,\\ &\overline{X}_7=(\cos\varphi q_0,\ \sin\varphi q_1,\ -r(1-r^2)^{1/2}q_2,\dots,-r(1-r^2)^{1/2}q_m)\\ &\overline{X}_{7+k}=(0,0,j_k(1-r^2)^{1/2}q_2,\dots,j_k(1-r^2)^{1/2}q_m) && k=1,2,3,\end{aligned}$$

are orthogonal tangent vectors to $\overline{M}$ at q. Moreover if,

$$(3.3)\qquad W_q=\{X=(0,0,x_2,\dots,x_m)\in Q^{m+1}\,|\,(X,q)=0\},$$

then the tangent space to $\overline{M}$ at q is $T_q\overline{M}=W_q\oplus\mathrm{Sp}\{\overline{X}_1,\dots,\overline{X}_{10}\}$.

From (3.1),

$$(3.4)\qquad \overline{N}_q=(-\sin\varphi q_1j_1,\ \cos\varphi q_0j_1,0,\dots,0)$$

is a unit normal vector to $\overline{M}$ at q.

From the above expression and by a direct computation we have

$$(3.5)\qquad \overline{A}\overline{X}_k=-\frac{1}{r}\overline{X}_{3+k},\quad \overline{A}\overline{X}_{3+k}=-\frac{1}{r}\overline{X}_k,\quad \overline{A}X=0\quad k=1,2,3,$$

for any $X\in T_q\overline{M}$, X being orthogonal to $\mathrm{Sp}\{\overline{X}_1,\dots,\overline{X}_6\}$, where $\overline{A}$ is the Weingarten endomorphism of $\overline{M}$.

Let $q\in\overline{M}$, as $\overline{M}$ is invariant under the action of S^3 we have that a unit normal vector to M at $\pi(q)=x$ is given by

$$(3.6)\qquad N_x=(\pi_*)_q\overline{N}_q.$$

Moreover, the vertical subspace is spanned by the vectors

$$(3.7)\qquad V_k=j_kq=r\overline{X}_k+\overline{X}_{7+k},\qquad k=1,2,3.$$

Let $\overline{Y}_k=(1-r^2)^{-1/2}(\overline{X}_k-g_0(\overline{X}_k,V_k)V_k)$, $k=1,2,3$. From (3.2) and (3.7) the horizontal subspace at q is $T'_q=W_q\oplus\mathrm{Sp}\{\overline{Y}_1,\overline{Y}_2,\overline{Y}_3,\overline{X}_4,\overline{X}_5,\overline{X}_6,\overline{X}_7\}$. Thus, from (2.4) and (3.2).

$$(3.8)\qquad (\pi_*)_q(\overline{Y})_k=Y_k,\quad (\pi_*)_q(\overline{X}_{3+k})=J_kN_q,\quad (\pi_*)_q(\overline{X}_7)=Y,\quad k=1,2,3,$$

are tangent vectors to M at x, and

$$(3.9)\qquad J_k Y_k = -(1-r^2)^{-1/2} Y, \qquad k=1, 2, 3.$$

As $\pi : \overline{M} \to M$ is a Riemannian submersion with totally geodesic fibres, from (3.5), (3.6), (3.7), (3.8) and (3.9) we can conclude that

$$(3.10)\qquad A(\pi_* X) = \pi_* AX = 0, \text{ for any } X \in W_q, \ AY = \pi_* AX_7 = 0,$$

$$AJ_k Y = -(1-r^2)^{1/2} r^{-1} J_k N, \ AJ_k N = -r^{-1} J_k Y, \ k=1, 2, 3,$$

where by A we denote the Weingarten endomorphism of M in QP^m.

Now the proof follows from (2.11) and (3.10).

Remark. As in the above Proposition it is easy to verify that if $\overline{M}_k = \{q = (r\cos\varphi q_0, r\sin\varphi q_1, (1-r^2)^{1/2} q_2, \ldots, (1-r^2)^{1/2} q^m) \in S^{4m+3} \mid 0 < r < 1, \ 0 \leqq \varphi < 2\pi, \ |q_0| = |q_1| = 1, \ g_0(r\cos\varphi q_0, r\sin\varphi q_1 j_k) = 0\}$, $k=2, 3$, then $\pi(\overline{M}_k) = M_k$ is a minimal ruled real hypersurface of QP^m, $k=2, 3$.

4. Real hypersurfaces of QP^m with constant quaternionic sectional curvatures. Let M be a real hypersurface of QP^m and $x \in M$. We denote by $\mathbf{UD} = \{X \in \mathbf{D} \mid \|X\| = 1\}$ and $\mathbf{UD}_x$ the unit sphere in D_x.

Definition 2. *Let $X \in \mathbf{UD}$ and $Q(X)$ be the 4-plane spanned by X, J_1X, J_2X and J_3X. We shall say that M has constant quaternionic sectional curvatures if for any $X \in UD$ and for any plane Σ in $Q(X)$ the sectional curvature K of Σ $(K(\Sigma))$ is constant.*

Let $x \in M$ and $X \in \mathbf{UD}_x$. From (2.8) we have

$$(4.1)\qquad K(Z, W) = R(Z, W, W, Z) = 1 + 3\Sigma_{k=1}^{3} g(Z, J_k W)^2 + g(AZ, Z)\, g(AW, W) - g(AZ, W)^2,$$

for any orthonormal tangent vector fields $Z, W \in Q(X)$.

So, if by Σ_k we denote the plane spanned by X and J_kX, $k=1, 2, 3$, then

$$(4.2)\qquad K(\Sigma_k) = 4 + g(AX, X)\, g(AJ_kX, J_kX) - g(AX, J_kX)^2, \quad k=1, 2, 3.$$

Theorem. *Let M be a connected real hypersurface of QP^m, $m>3$. Then, M has constant quaternionic sectional curvatures if and only if M is one of the following:*

(1) A ruled real hypersurface,

(2) An open subset of a geodesic hypersphere.

Proof. Let $x \in M$ and $X \in \mathbf{UD}_x$, as M has constant quaternionic sectional curvatures, $K(\Sigma_k) = C = \text{constant}$, $k=1, 2, 3$. Thus if $\alpha(t)$ is a C^∞-curve over $\mathbf{UD}_x$ with $\alpha(0) = X$ and $\alpha'(0) = Y$, then by differentiation of (4.2) we obtain,

$$(4.3)\qquad 0 = 2g(AX, Y)\, g(AJ_kX, J_kX) - 2g(AX, X)\, g(AJ_kX, J_kY) - 2g(AX, J_kX)\, g((AJ_k - J_kA)X, Y)^2, \quad k=1, 2, 3,$$

and

$$(4.4)\qquad 0 = 2g(AY, Y)\, g(AJ_kX, J_kX) + 8g(AX, Y)\, g(AJ_kX, J_kY) + 2g(AX, X)\, g(AJ_kY, J_kY) - 2g((J_kA - AJ_k)X, Y)^2 - 4g(AX, J_kX)\, g(AY, J_kY) - 4(C-4).$$

On the other hand, it is clear that there exists an orthonormal basis of T_xM, $\{X_1, \ldots, X_{4m-4}, U_1, U_2, U_3\}$ such that

$$(4.5)\qquad AX_i = \lambda_i X_i + a_{i1}U_1 + a_{i2}U_2 + a_{i3}U_3, \quad i=1, \ldots, 4m-4.$$

From (4.3) and (4.5) we have that for any $i, j \in \{1, \ldots, 4m-4\}$, $i \neq j$,

$$(4.6)\qquad \lambda_i g(AJ_kX_i, J_kX_j) = 0, \qquad k=1, 2, 3,$$

and so, either $\lambda_i = 0$ or $AJ_kX_i \in \mathrm{Sp}\{J_kX_i \oplus D'$, $k=1, 2, 3$. From this, we conclude that the above basis can be written as $\{X_1, \ldots, X_{m-1}, X_m = J_1X_1, \ldots, X_{2m-2} = J_1X_{m-1}, X_{2m-1} = J_2X_1, \ldots, X_{3m-3} = J_2X_{m-1}, X_{3m-2} = J_3X_1, \ldots, X_{4m-4} = J_3X_{m-1}, U_1, U_2, U_3\}$, with

$$(4.7)\qquad AX_i = \lambda_i X_i + a_{i1}U_1 + a_{i2}U_2 + a_{i3}U_3,$$

$$AJ_k X_i = \lambda_i^k X_i + a_{i1}^k U_1 + a_{i2}^k U_2 + a_{i3}^k U_3, \quad k=1, 2, 3, \ i=1, \ldots, m-1.$$

From (4.4) and (4.7),

$$(4.8)\qquad 2(C-4) = \lambda_i\lambda_j^k + \lambda_j\lambda_i^k, \quad i \neq j, \ i, j \in \{1, \ldots, m-1\}, \ k=1, 2, 3.$$

As from (4.2) $4 + \lambda_i\lambda_i^k = 4 + \lambda_j\lambda_j^k = C$, then by using (4.8) we can see that $\lambda_i^k = \lambda_i = \lambda_j^k = \lambda$, $k=1, 2, 3$, $i, j \in \{1, \ldots, m-1\}$ and we conclude that,

$$(4.9)\qquad AZ = \lambda Z + \Sigma_{k=1}^{3} g(AZ, U_k) U_k,$$

for any $Z \in \mathbf{D}$, with $4 + \lambda^2 = C$.

From (4.9), if $\lambda = 0$, $C = 4$ and M is ruled. Then, in the following we suppose that in (4.9) $\lambda = \text{constant} \neq 0$.

If we write

$$(4.10)\qquad AU_k = c_kE_k + b_{k1}U_1 + b_{k2}U_2 + b_{k3}U_3, \qquad k=1, 2, 3,$$

with $E_k \in \mathbf{UD}$, $k=1, 2, 3$, and

$$(4.11)\qquad AE_k = \lambda E_k + d_{k1}U_1 + d_{k2}U_2 + d_{k3}U_3, \qquad k=1, 2, 3,$$

then, as $m>3$, there exists $X \in \mathbf{D}$ orthogonal to E_k and J_iE_k, $i, k=1, 2, 3$. Thus from (4.9), (4.10) and (4.11),

$$(4.12)\qquad AX = \lambda X, \ AJ_kX = \lambda J_kX, \qquad k=1, 2, 3.$$

From (2.9) and (4.12), $(\nabla_X A)J_kX - (\nabla_{J_kX} A)X = -2U_k = (\lambda - A)[X, J_kX]$, $k=1, 2, 3$. Therefore, from (2.10), (4.11) and (4.12) we have

$$(4.13)\qquad 0 = g((\nabla_X A)J_kX - (\nabla_{J_kX} A)X, E_i) = g(\nabla_X J_kX, d_{i1}U_1 + d_{i2}U_2 + d_{i3}U_3) - g(\nabla_{J_kX} X, d_{i1}U_1 + d_{i2}U_2 + d_{i3}U_3) = 2d_{i1}\lambda g(J_kX, J_1X) + 2d_{i2}\lambda g(J_kX, J_2X) + 2d_{i3}\lambda g(J_kX, J_3X), \qquad k, i=1, 2, 3.$$

As $\lambda \neq 0$, then $d_{ij} = 0$, $i, j=1, 2, 3$. That is, E_1, E_2 and E_3 are principal vectors. Thus

$$(4.14)\qquad AZ = \lambda Z \text{ for any } Z \in \mathbf{D}.$$

From (4.14) it is clear that we can choose a local basis of V such that U_1, U_2 and U_3 are principal vectors, that is, we can suppose that,

$$AU_k = a_k U_k, \qquad k = 1, 2, 3, \tag{4.15}$$

and so, from (2.9), (4.12) and (4.15), $-2 = g((\nabla_X A)J_k X - (\nabla_{J_k X} A)X, U_k) = 2(\lambda - a_k)\lambda$. Consequently, U_1, U_2 and U_3 are principal vectors with the same principal curvature. Then (see [5]) M is an open subset of a geodesic hypersphere of QP^m.

REFERENCES

1. Barbosa J. L. M., Delgado J. A. — *Ruled submanifolds of space forms with mean curvature of nonzero constant length*, Amer. J. Math., 106 (1984), 763–780.
2. Ishihara S. — *Quaternion Kählerian manifolds*, J. Differential Geometry, 9 (1974) 483–500.
3. Kimura M. — *Sectional curvatures of holomorphic planes on a real hypersurface in P^n (C)*, Preprint.
4. Martinelli E. — *Modelo metrico reale dello spazio proiettivo quaternionale*, Ann. Mat. Pur. Appl., 49 (1960), 73–90.
5. Martinez A., Perez J. D. — *Real hypersurfaces in quaternionic projective space*, Ann. Mat. Pur. Appl. to appear.
6. Martinez A., Perez J. D., Santos F. G. — *Generic submanifolds of a quaternion Kaehlerian manifold*, Soochow J. Math. 10 (1984), 79–98.

Received 18.IX.1986

Departamento de Geometria y Topologia
Facultad de Ciencias
Universidad de Granada
18071 GRANADA, SPAIN

Analele ştiinţifice ale Universităţii „Al. I. Cuza" din Iaşi
Tomul XXXIV, s. I a. Matematică, 1988, f. 1

THERMO-ACOUSTICAL WAVES IN LINEAR HOMOGENEOUS ISOTROPIC THERMO-VISCOELASTIC MATERIALS OF INTEGRAL TYPE

BY

IOANA LUCA

1. Introduction. An unrealistic consequence of the parabolic type equation of heat conduction based upon Fourier's law is that a thermal disturbance at any point in the body is felt instantaneously at all other points. But the experiences made with HeII have shown that the thermal pulses are propagating at finite speed. In order to remedy this so-called „paradox of heat conduction", different theories have been proposed. A first solution has been offered by the equation of heat flux deduced on kinetic-probabilistic grounds by Cattaneo [1], [2] and assumed by Vernotte in [3], [4]. Its use in [5]–[15] has shown that the second sound is possible. Upon the basis of unfounded analogies, the Cattaneo-Vernotte's equation has been deduced by Kaliski [16] within the framework of the Onsager type thermodynamical theory and Fox [17] has derived its objective form in the non-linear case. The entropy inequalities proposed by Müller [18] and Green and Laws [19], as well as the assumption of a constitutive equation for the thermal energy flux by Ghaleb [20] are staying at the basis of some theories which supply finite propagation speeds of thermal disturbances (see [21]–[31]). Also, the thermodynamical theory with internal state variables takes into account the possibility of the second sound (see [32]–[39]).

The idea for giving a constitutive equation for the heat flux independent of the present temperature gradient, analogous with Cattaneo-Vernotte-Kaliski's law, has lied at the basis of the theory of rigid heat conductors with fading memory developed by Curtin and Pipkin [40]. The thermal waves are propagating at finite speed (see [40]–[42]). The theory developed in [40] has been generalized by Mc Carthy [43] in order to take into account the body deformation too. The constitutive equations from [43] have been linearized in [44]. Mc Carthy investigated in [45] the growth and decay of the amplitudes of thermal waves, in the nonlinear rigid heat conductor introduced in [43]. In [46] he examined the thermomechanical waves in the nonlinear one-dimensional material introduced in [43].

In this paper we shall examine the propagation of thermo-acoustical waves in the linear homogeneous isotropic material considered in [44]. It will be shown that two purely mechanical transversal waves and two coupled longitudinal waves are propagating at constant speeds which are depending on the instantaneous material answer. Their amplitudes illustrate the ma-