ON THE LOCAL STRUCTURE OF GENERALIZED KÄHLER MANIFOLDS

LIVIU ORNEA AND RADU PANTILIE

Abstract

Let (g,b,J_+,J_-) be the bihermitian structure corresponding to a generalized Kähler structure. We find natural integrability conditions, in terms of the eigendistributions of $J_+J_- + J_-J_+$, under which $\mathrm{d}b=0$.

Introduction

A *generalized almost complex structure* on a smooth (connected) manifold is given by a vector subbundle $L\subset\big(TM\oplus T^*M\big)^{\mathbb{C}}$ such that $L\cap\overline{L}=\{0\}$ and which is maximally isotropic with respect to the canonical inner product

$$<X+\alpha, Y+\beta>=\tfrac12\big(\alpha(Y)+\beta(X)\big)\;.$$

If $E=\pi_{TM}(L)$ is a bundle, where $\pi_{TM}:TM\oplus T^*M\to TM$ is the projection, then there exists a unique complex two-form $\varepsilon\in\Gamma(\Lambda^2E^*)$ such that $L=L(E,\varepsilon)$, where

$$L(E,\varepsilon)=\{X+\alpha\,|\,X\in E, \alpha|_E=\varepsilon(X)\}\;.$$

Furthermore, by [4] , to which we refer for all of the facts on generalized complex structures recalled here, the condition $L\cap\overline{L}=\{0\}$ is equivalent to $E+\overline{E}=T^{\mathbb{C}}M$ and $\mathrm{Im}\big(\varepsilon|_{E\cap\overline{E}}\big)$ is non-degenerate.

A generalized almost complex structure L is *integrable* if its space of sections is closed under the *Courant bracket*, defined by

$$[X+\alpha, Y+\beta]=[X,Y]+\mathcal{L}_X\beta-\mathcal{L}_Y\alpha-\tfrac12\,\mathrm{d}(\iota_X\beta-\iota_Y\alpha)\;,$$

for any $X+\alpha, Y+\beta\in\Gamma(L)$.

A *generalized complex structure* is an integrable generalized almost complex structure. Obviously, any generalized complex structure corresponds to a linear complex structure on $TM\oplus T^*M$ whose eigenbundle, corresponding to i , is isotropic, with respect to the canonical inner product, and its space of sections is

2000 *Mathematics Subject Classification.* 53C55.

Key words and phrases. generalized Kähler manifold.

The authors are partially supported by a PN II IDEI Grant, code 1193.

closed under the Courant bracket.

A generalized almost complex structure of the form $L = L(E, \varepsilon)$ is integrable if and only if the space of sections of E is closed under the (Lie) bracket and $\mathrm{d}\varepsilon(X, Y, Z) = 0$, for any $X, Y, Z \in E$.

A particular feature of Generalized Complex Geometry is that imposing Hermitian compatibility to a generalized almost complex structure and a Riemannian metric on $TM \oplus T^*M$, compatible with the canonical inner product, forces the manifold to admit a second generalized almost complex structure, commuting with the first one. One arrives to the notion of *generalized Kähler structure*, as a couple of commuting generalized complex structures $\mathcal{J}_1$ and $\mathcal{J}_2$ such that $\mathcal{J}_1\mathcal{J}_2$ is negative definite; furthermore, in [4] it is explained the correspondence between generalized Kähler structures and a special type of bihermitian structures which appeared in Theoretical Physics, over twenty years ago [3].

More precisely, any generalized almost Kähler structure on M corresponds to a quadruple (g, b, J_+, J_-), where g is a Riemannian metric, b is a two-form and $J_\pm$ are almost Hermitian structures on (M, g). Furthermore, the corresponding generalized almost Kähler structure is integrable if and only if $J_\pm$ are integrable and parallel with respect to $\nabla^\pm$, where $\nabla^\pm = \nabla \pm \frac{1}{2} g^{-1} h$, with ∇ the Levi-Civita connection of g and $h = \mathrm{d}b$ (equivalently, $J_\pm$ are integrable and $\mathrm{d}^c_\pm \omega_\pm = \mp h$, where $\omega_\pm$ are the Kähler forms of $J_\pm$).

Classification results for compact bihermitian manifolds were given, mainly in dimension 4, in several papers (see, for example, [1], [2]).

In higher dimensions, a natural case to consider is when J_+ and J_- are admissible for an almost quaternionic structure. This condition was, essentially, considered by physicists who have shown that it holds if and only if the bihermitian structure is part of a hyperkähler one [7, Theorem 1] (see Theorem 1.1, below).

By combining this fact with results of [9] and [8], we study the 'eigendistributions' of the operator $J_+J_- + J_-J_+$. Thus, we obtain natural integrability conditions under which $\mathrm{d}b = 0$ (Theorem 2.3, Corollary 2.4).

1. The almost quaternionic generalized Kähler manifolds are hyperkähler

A *bundle of associative algebras* is a vector bundle whose typical fibre is an associative algebra $\mathcal{A}$ and whose structural group is the group of automorphisms of $\mathcal{A}$.

An *almost quaternionic structure* on M is a morphism of bundles of associative algebras $\sigma : A \to \mathrm{End}(TM)$, where the typical fibre of A is $\mathbb{H}$. Then, $\sigma(\mathrm{Im}A)$

is an oriented Riemannian vector bundle of rank 3 and the (local) sections of its sphere bundle are the *admissible almost complex structures* of σ (see [6]).

The following result reformulates [7, Theorem 1] . For the reader's convenience, we supply a proof.

Theorem 1.1. *Let (M, L_1, L_2) be a generalized almost Kähler manifold of dimension at least eight and let (g, b, J_+, J_-) be the corresponding almost bihermititan structure. Suppose that J_+ and J_- are admissible almost complex structures of an almost quaternionic structure on M.*

Then the following assertions are equivalent:

(i) *(M, L_1, L_2) is generalized Kähler.*

(ii) *$(M, g, J_\pm)$ are Kähler manifolds.*

Furthermore, if (i) *or* (ii) *holds and $J_+ \neq \pm J_-$ then the almost quaternionic structure is hyperkähler, with respect to (M, g) .*

Proof. As (ii)$\Longrightarrow$(i) is trivial, it is sufficient to prove that (i)$\Longrightarrow$(ii) .

By hypothesis, there exists $a : M \to [-1, 1]$ such that $J_+J_- + J_-J_+ = -2a$ on M. If $J_+ = \pm J_-$ there is nothing to be proved. Hence, we may suppose that $a^{-1}\big((-1, 1)\big) \neq \emptyset$.

Moreover, as we have to prove that $(M, g, J_\pm)$ are Kähler and, consequently, a is constant, we may assume $a(M) \subseteq (-1, 1)$.

Then $L_1 = L(T^{\mathbb{C}}M, \varepsilon_+)$ and $L_2 = L(T^{\mathbb{C}}M, \varepsilon_-)$, where $\varepsilon_\pm$ are closed complex two-forms on M. From [4, (6.4) and (6.5)] , it quickly follows that

$$\begin{aligned} &(\mathrm{Im}\,\varepsilon_\pm)(J_+ \mp J_-) = 2g \ , \\ &(\mathrm{Re}\,\varepsilon_\pm)(J_+ \mp J_-) = b(J_+ \mp J_-) + g(J_+ \pm J_-) \ . \end{aligned} \tag{1.1}$$

On multiplying, to the right, both relations of (1.1) by $J_+ \mp J_-$ we obtain

$$\begin{aligned} &(-2 \pm 2a)(\mathrm{Im}\,\varepsilon_\pm) = 2g(J_+ \mp J_-) \ , \\ &(-2 \pm 2a)(\mathrm{Re}\,\varepsilon_\pm) = (-2 \pm 2a)b \mp g(J_+J_- - J_-J_+) \end{aligned}$$

and, consequently, $(a - 1)\mathrm{Re}\,\varepsilon_+ - (a + 1)\mathrm{Re}\,\varepsilon_- = -2b$.

Therefore

$$\mathrm{d}\left[\frac{1}{1 \pm a} g(J_+ \pm J_-)\right] = 0 \ . \tag{1.2}$$

Also, as, up to a B-field transformation, we may suppose $\mathrm{Re}\,\varepsilon_- = 0$, we deduce that the two-form $\frac{1}{a-1}b$ is closed; equivalently,

$$\mathrm{d}b = \frac{1}{a - 1}\,\mathrm{d}a \wedge b \ . \tag{1.3}$$

Note that, the condition $\nabla^{\pm} J_{\pm} = 0$ is equivalent to

$$g\big((\nabla_X J_{\pm})(Y), Z\big) = \mp\tfrac{1}{2}\big[(\mathrm{d}b)(X, J_{\pm}Y, Z) + (\mathrm{d}b)(X, Y, J_{\pm}Z)\big] \ , \tag{1.4}$$

for any $X, Y, Z \in TM$.

From (1.3) and (1.4) we obtain

$$g\big((\nabla_X J_{\pm})(Y), Z\big) = \pm\frac{1}{2(1-a)}\big(\mathrm{d}a \wedge b\big)\big(X \wedge J_{\pm}Y \wedge Z + X \wedge Y \wedge J_{\pm}Z\big) \ , \tag{1.5}$$

for any $X, Y, Z \in TM$.

Obviously,

$$K_{\pm} = \frac{1}{\sqrt{2(1 \pm a)}}\big(J_+ \pm J_-\big) \ .$$

are anti-commuting almost Hermitian structures on (M, g). Furthermore, (1.5) gives

$$\begin{aligned} g\big((\nabla_X K_{\pm})(Y), Z\big) &= \mp\frac{1}{2(1 \pm a)}\, X(a)\, g(K_{\pm}Y, Z) \\ &\quad + \frac{1}{2(1-a)}\left(\frac{1-a}{1+a}\right)^{\pm\frac{1}{2}}\big(\mathrm{d}a \wedge b\big)\big(X \wedge K_{\mp}Y \wedge Z + X \wedge Y \wedge K_{\mp}Z\big) \ , \end{aligned} \tag{1.6}$$

for any $X, Y, Z \in TM$.

On the other hand, by (1.2), the almost Hermitian manifolds $\big(M, e^{2f_{\pm}}g, K_{\pm}\big)$ are (1,2)-symplectic, where $f_{\pm} = -\frac{1}{4}\log 2(1 \pm a)$. A straightforward calculation shows that this is equivalent to

$$\begin{aligned} & g\big((\nabla_{K_{\pm}X} K_{\pm})(Y), Z\big) - g\big((\nabla_X K_{\pm})(Y), K_{\pm}Z\big) = \\ & \qquad \pm\frac{1}{2(1 \pm a)}\big[(K_{\pm}Y)(a)\, g(K_{\pm}X, Z) - (K_{\pm}Z)(a)\, g(K_{\pm}X, Y) \\ & \qquad\qquad + Y(a)\, g(X, Z) - Z(a)\, g(X, Y)\big] \ , \end{aligned} \tag{1.7}$$

for any $X, Y, Z \in TM$.

Now, (1.6) and (1.7) imply

$$\begin{aligned} & (K_{\pm}X)(a)\, g(K_{\pm}Y, Z) + (K_{\pm}Y)(a)\, g(K_{\pm}X, Z) - (K_{\pm}Z)(a)\, g(K_{\pm}X, Y) \\ & \qquad - X(a)\, g(Y, Z) + Y(a)\, g(X, Z) - Z(a)\, g(X, Y) = \\ & \qquad \pm\left(\frac{1-a}{1+a}\right)^{-\frac{1}{2}}\big(\mathrm{d}a \wedge b\big)\big(K_{\pm}X \wedge K_{\mp}Y \wedge Z + K_{\pm}X \wedge Y \wedge K_{\mp}Z \\ & \qquad\qquad - X \wedge K_{\mp}Y \wedge K_{\pm}Z - X \wedge Y \wedge K_{\mp}K_{\pm}Z\big) \ , \end{aligned} \tag{1.8}$$

for any $X, Y, Z \in TM$.

In (1.8), if from the first relation we subtract the second one, with the roles of

X and Y interchanged, then we obtain

$$\begin{aligned}&(K_+X)(a)\,g(K_+Y,Z)+(K_+Y)(a)\,g(K_+X,Z)-(K_+Z)(a)\,g(K_+X,Y)\\&+(K_-X)(a)\,g(K_-Y,Z)+(K_-Y)(a)\,g(K_-X,Z)+(K_-Z)(a)\,g(K_-X,Y)\\&-2Z(a)\,g(X,Y)=2\left(\frac{1-a}{1+a}\right)^{-\frac{1}{2}}\big(\mathrm{d}a\wedge b\big)\big(K_+X\wedge K_-Y\wedge Z\big)\,,\end{aligned}\tag{1.9}$$

for any $X,Y,Z\in TM$.

From (1.9), with $Z=K_+X$, it quickly follows that $\mathrm{grad}_g a$ is zero on the orthogonal complement of each quaternionic line. As $\dim M\geq 8$, we obtain that a is constant. Together with (1.6), this gives that $K_\pm$ generate a hyperkähler structure on (M,g), whilst, together with (1.3), this implies $\mathrm{d}b=0$. The proof is complete. □

Remark 1.2. In dimension four, the hypothesis of Theorem 1.1 is equivalent to the condition that J_+ and J_- induce the same orientation on M, whilst if J_+ and J_- induce different orientations on M then, up to a unique B-field transformation, M is locally given by a product of two Kähler manifolds (consequence of [8, Corollary 5.7]). Furthermore, there exist four-dimensional generalized Kähler manifolds with J_+ and J_- inducing the same orientation and which are not given by a hyperkähler structure (see [5]).

The next result follows quickly from (1.3) and (1.9).

Corollary 1.3. *Let (M,L_1,L_2) be a four-dimensional generalized Kähler manifold with J_+, J_- inducing the same orientation on M and linearly independent, at each point.*

Then, up to a unique B-field transformation, the following relations hold:

$$\begin{aligned}\mathrm{d}b&=-\frac{1}{1-a}\,\mathrm{d}a\wedge b\,.\\ *(\mathrm{d}a\wedge b)&=\frac{1}{2(1+a)}\,[J_+,J_-](\mathrm{d}a)\,,\end{aligned}\tag{1.10}$$

where $*$ is the Hodge star operator of (M,g) and the function $a:M\to(-1,1)$ is characterised by $J_+J_-+J_-J_+=-2a$.

We end this section by showing how equations (1.10) can be slightly simplified.

Remark 1.4. Let (M,L_1,L_2) be a four-dimensional generalized Kähler manifold with J_+, J_- inducing the same orientation on M and linearly independent, at each point.

With the same notations as in Theorem 1.1, let $K=K_+K_-$, $k=\left(\frac{1+a}{1-a}\right)^{\frac{1}{2}}g$ and

$u = \log(1-a)$.

Then (1.10) is equivalent to

$$\mathrm{d}b = \mathrm{d}u \wedge b = - *_k K \mathrm{d}u \; . \tag{1.11}$$

If $\mathrm{d}u$ is nowhere zero, then the second equality of (1.11) is equivalent to

$$b = cv_{\mathscr{E}} + v_{\mathscr{F}} + \mathrm{d}u \wedge \alpha \; ,$$

where c is a function, $\mathscr{E}$ is generated by $\{\operatorname{grad} u, K(\operatorname{grad} u)\}$, $\mathscr{F} = \mathscr{E}^{\perp}$, α is a section of $\mathscr{F}^*$, and $v_{\mathscr{E}}$, $v_{\mathscr{F}}$ are the volume forms of $\mathscr{E}$, $\mathscr{F}$, respectively.

2. Factorisation results for generalized Kähler manifolds

Let (M, L_1, L_2) be a generalized Kähler manifold and let (g, b, J_+, J_-) be the corresponding bihermitian structure. For any $a \in [-1,1]$, we (pointwisely) denote by $\mathscr{H}^a$ the eigenspace of $J_+J_- + J_-J_+$ corresponding to $-2a$; also, we denote $\mathscr{H}^{\pm} = \mathscr{H}^{\pm 1}$ and $\mathscr{V} = \big(\mathscr{H}^+ \oplus \mathscr{H}^-\big)^{\perp}$. Then, at each point of M, we have that $\mathscr{H}^a$ are preserved by $J_{\pm}$ and there exist (finite) orthogonal decompositions $TM = \bigoplus_a \mathscr{H}^a$ and $\mathscr{V} = \bigoplus_{|a|<1} \mathscr{H}^a$.

Corollary 2.1. *Let N be a complex submanifold of $(M, J_{\pm})$, of complex dimension at least four, endowed with a function $a : N \to (-1,1)$ such that $T_xN \subseteq \mathscr{H}_x^{a(x)}$, $(x \in N)$.*

Then a is constant and N is endowed with a natural hyperkähler structure whose underlying Riemannian metric is $g|_N$ and for which $J_+|_N$ and $J_-|_N$ are admissible complex structures.

Proof. As, obviously, (g, b, J_+, J_-) induces a generalized Kähler structure on N, this follows quickly from Theorem 1.1. □

From [9, Lemma 2.3] it follows that in an open neighbourhood U of each point of a dense open subset of M there exist (smooth) functions $a_j : M \to [-1,1]$, $(j = 1, \dots, r)$, such that $\mathscr{H}^{a_j}$ are distributions on U and $TM = \bigoplus_j \mathscr{H}^{a_j}$; we call the $\mathscr{H}^{a_j}$ the *(local) eigendistributions* of $J_+J_- + J_-J_+$. Furthermore, if a is a function on U such that, at each point, $-2a$ is an eigenvalue of $J_+J_- + J_-J_+$ then there exists an open subset of U on which $a = a_j$, for some j; thus, if we assume real-analyticity then $a = a_j$ on U.

We point out the following facts:

- *The functions a_j are constant along the integrable manifolds, of dimensions at least eight, of $\mathscr{H}^{a_j}$, $(j = 1, \dots, r)$*; this is a consequence of Corollary 2.1.
- *If $J_+ \pm J_-$ are invertible then the holomorphic diffeomorphisms of (M, L_1, L_2) preserve each $\mathscr{H}^{a_j}$, $(j = 1, \dots, r)$*; this is a consequence of [8, Corollary 6.7].

Remark 2.2. Let (M, L_1, L_2) be a generalized Kähler manifold with $\mathrm{d}b = 0$. Then $(M, g, J_\pm)$ are Kähler and there exists a nonempty finite subset A of $[-1, 1]$ such that, for any $a \in A$, we have that $\mathscr{H}^a$ is a parallel foliation which is holomorphic with respect to both J_+ and J_-. Therefore $(g, J_\pm)$ induce Kähler structures on the leaves of $\mathscr{H}^a$ and, if $a \neq \pm 1$, these are admissible with respect to natural hyperkähler structures. Furthermore, there exist orthogonal decompositions $TM = \bigoplus_{a\in A} \mathscr{H}^a$ and $\mathscr{V} = \bigoplus_{a\in A\setminus\{\pm1\}} \mathscr{H}^a$.

If the cardinal of $A \setminus \{\pm 1\}$ is at least two then the leaves of $\bigoplus_{a\in A\setminus\{\pm1\}} \mathscr{H}^a$ are naturally endowed with two distinct hyperkähler structures with respect to which J_+ and J_- define admissible complex structures, respectively.

Furthermore, if $J_+ + J_-$ (or $J_+ - J_-$) is invertible then as, locally, M is the product of a Kähler manifold and hyperkähler manifolds, its holomorphic Poisson structure is the pull-back of the product of the holomorphic symplectic structures of the hyperkähler factors.

Next, we prove the following.

Theorem 2.3. *Let (M, L_1, L_2) be a generalized Kähler manifold with $J_+ + J_-$ (or $J_+ - J_-$) invertible and for which the eigendistributions of $(J_+J_- + J_-J_+)|_{(\mathscr{H}^+\oplus\mathscr{H}^-)^\perp}$ have dimensions at least eight.*

Then the following assertions are equivalent:

(i) $\mathrm{d}b = 0$.

(ii) *The eigendistributions of $J_+J_- + J_-J_+$ and their orthogonal complements are integrable.*

Proof. The implication (i)$\Longrightarrow$(ii) is an immediate consequence of Remark 2.2.

Assume that (ii) holds. From [8, Corollary 6.3] it follows that we may suppose that, also, $J_+ - J_-$ is invertible.

Then, locally, outside a set with empty interior there exists a finite set A of functions $a : M \to (-1, 1)$ such that $\mathscr{H}^a$ are distributions and $TM = \bigoplus_{a\in A} \mathscr{H}^a$.

Also, $L_1 = L(T^{\mathbb{C}}M, \varepsilon_+)$ and $L_2 = L(T^{\mathbb{C}}M, \varepsilon_-)$, where $\varepsilon_\pm$ are closed complex two-forms on M.

By Theorem 1.1, we have that (i) holds if and only if $\mathrm{d}b(X, Y, Z) = 0$, for any $X \in \mathscr{H}^a$ and $Y, Z \in \bigoplus_{a'\in A\setminus\{a\}} \mathscr{H}^{a'}$, $(a \in A)$.

As $\mathscr{H}^a$, $(a \in A)$, are invariant under B-field transformations, we may assume $\mathrm{Re}\,\varepsilon_- = 0$; equivalently, $b = -g(J_+ - J_-)(J_+ + J_-)^{-1}$. Together with the fact that $\mathscr{H}^a$, $(a \in A)$, and their orthogonal complements are holomorphic foliations, with respect to J_+ and J_-, this gives that (i) holds if and only if $\mathscr{H}^a$ are Riemannian foliations, $(a \in A)$.

Now, note that we, also, have

$$\mathrm{Re}\,\varepsilon_+ = b+g(J_++J_-)(J_+-J_-)^{-1} = g\big[(J_++J_-)(J_+-J_-)^{-1}-(J_+-J_-)(J_++J_-)^{-1}\big]\ .$$

As L_1 is integrable, $\mathrm{Re}\,\varepsilon_+$ is closed and, consequently, $\mathscr{H}^a$ are Riemannian foliations, $(a \in A)$.

The proof is complete. □

We end with the following result.

Corollary 2.4. *Let (M, L_1, L_2) be a generalized Kähler manifold for which the eigendistributions of $(J_+J_- + J_-J_+)|_{(\mathscr{H}^+\oplus\mathscr{H}^-)^\perp}$ have dimensions at least eight.*

Then the following assertions are equivalent:

(i) $\mathrm{d}b = 0$.

(ii) *$\mathscr{H}^\pm$ and the sum of any two eigendistributions of $J_+J_- + J_-J_+$ are integrable.*

Proof. The implication (i)$\Longrightarrow$(ii) is trivial.

If (ii) holds then $\mathscr{H}^+ \oplus \mathscr{H}^-$ is integrable. Hence, by [8, Theorem 6.10], we may assume $\mathscr{H}^+ = 0 = \mathscr{H}^-$. The proof follows from Theorem 2.3. □

References

[1] V. Apostolov, P. Gauduchon, G. Grantcharov, Bihermitian surfaces on complex surfaces, *Proc. London Math. Soc.*, **79** (1999), 414–428; *Corrigendum*, **92** (2006), 200–202.

[2] V. Apostolov, M. Gualtieri, Generalized Kähler manifolds, commuting complex structures, and split tangent bundle, *Commun. Math. Phys.*, **271** (2007), 561–575.

[3] S. J. Gates, C. M. Hull, M. Roček, Twisted multiplets and new supersymmetric nonlinear sigma models, *Nuc. Phys. B*, **248** (1984), 157–186.

[4] M. Gualtieri, Generalized complex geometry, D. Phil. Thesis, University of Oxford, 2003.

[5] N. J. Hitchin, Instantons, Poisson structures and Generalized Kähler Geometry, *Comm. Math. Phys.*, **265** (2006) 131-164.

[6] S. Ianus, S. Marchiafava, L. Ornea, R. Pantilie, Twistorial maps between quaternionic manifolds, *Ann. Sc. Norm. Super. Pisa Cl. Sci. (5)*, (to appear).

[7] U. Lindstrom, M. Roček, R. von Unge, M. Zabzine, Generalized Kähler manifolds and off-shell supersymmetry, *Commun. Math. Phys.*, **269** (2007) 833–849.

[8] L. Ornea, R Pantilie, Holomorphic maps between generalized complex manifolds, Preprint I.M.A.R., Bucharest, 2008, (arXiv:0810.1865).

[9] R. Pantilie, J. C. Wood, Harmonic morphisms with one-dimensional fibres on Einstein manifolds, *Trans. Amer. Math. Soc.*, **354** (2002) 4229–4243.

E-mail address: `lornea@gta.math.unibuc.ro, Radu.Pantilie@imar.ro`

L. Ornea, Universitatea din Bucureşti, Facultatea de Matematică, Str. Academiei nr. 14, 70109, Bucureşti, România, *and* Institutul de Matematică “Simion Stoilow” al Academiei Române, C.P. 1-764, 014700, Bucureşti, România

R. Pantilie, Institutul de Matematică "Simion Stoilow" al Academiei Române, C.P. 1-764, 014700, Bucureşti, România